MANAGEMENT OF INTENSIVE FEEDING SYSTEMS FOR BEEF CATTLE

by

STANLEY M. MYERS

B.S., Kansas State University, 1975

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTERS OF SCIENCE

Agricultural Economics

Department of Economics

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1979

Approved by:

John B. Riley

Major Professor

Spec Coll.
LD
2668
.T4
1979
M94
c.2

TABLE OF CONTENTS

Chapter

I. INTRODUCTION. 1

II. FIELD EXPERIMENT. 4

Experimental Procedure. 4
Results and Discussion. 11
Meat Sensory Characteristics and Quality Grades 11
Feeding Systems 11
Cattle Types. 12
Feeding Systems and Cattle Type Combinations. 12
Important Cost and Production Factors 17
Yardage 17
Interest. 17
Maintenance Requirements for Energy as a Percent of Consumption 17
Backgrounding 24
Ration Content. 25
Maturity Differences Associated with Cattle Types. 25
Breed Crosses Associated with Cattle Types. 27
Summary 27

III. SIMULATION MODEL 29

Introduction. 29
Model - Stage I 30
Model Formulation 31
Nutrients and Nutrient Requirements 31
Nutrient - Gain Relationships 34
Dry Matter Intake 39
Ration Type and Nutritional Restrictions. 42
Cost Factors. 44
Linear Programming Matrix 44
Application of Stage I - Traditional Steer and Heifer 47
Restrictions. 47
Selected Inputs 48
Ration Formulations 51
Results 51
Model - Stage II. 54
Formulation 54
Application 56
Results 59

IV. EVALUATING FEEDING SYSTEMS FOR GROUND BEEF PRODUCTION - "HAMBURGER STEER" (TRADITIONAL CATTLE TYPE). 62

Introduction. 62
Feeding Systems 63
Results 66
Summary and Conclusions 74

V. SUMMARY AND CONCLUSIONS, LIMITATIONS, AND SELECTED ADDITIONAL APPLICATIONS OF THE MODEL 76

Summary and Conclusions 76
Limitations 79
Selected Additional Applications of the Model 81

LIST OF REFERENCES 85

APPENDIX A. Example Matrix; Stage I, Traditional Steer, First Transition Ration, 607 lb. to 717 lb. Weight Range 89

APPENDIX B. Stage II Variable Name Description and Units, Flowchart Relating Print and Ration Selection Procedure, and an Example Program of Eight Ration Potential. 92

APPENDIX C. Stage II "To Date" and "Period" Production and Cost Analysis of the Stage I Constructed Steer and Heifer Feeding Systems. 108

APPENDIX D. "To Date" and "Period Production and Cost Analyses for Feeding Systems 1 Through 6. Chapter V - Evaluation of Traditional "Hamburger" Steers. . . . 124

LIST OF TABLES

Table 1. Field Experiment Feeding System for Accelerated-Fed Steers. 5

Table 2. Field Experiment Feeding System for Deferred-Fed Steers. 7

Table 3. Historic Feedstuff/Corn Price Ratios, Knasas 1979 - 1977 9

Table 4. Derived Prices for Feedstuffs 10

Table 5. Field Experiment Production and Cost Summary, All Accelerated-Fed Steers- 25 Head Average 13

Table 6. Field Experiment Production and Cost Summary, All Deferred-Fed Steers - 22 Head Average 14

Table 7. Field Experiment Production and Cost Summary, All Traditional Steers - 24 Head Average 15

Table 8. Field Experiment Production and Cost Summary, All Later-Maturing Steers - 23 Head Average 16

Table 9. Field Experiment Production and Cost Summary, Traditional Steers on the Accelerated Feeding System - 12 Head Average 18

Table 10. Field Experiment Production and Cost Summary, Later-Maturing Steers on the Accelerated Feeding System - 13 Head Average 19

Table 11. Field Experiment Production and Cost Summary, Traditional Steers on the Deferred Feeding System - 12 Head Average 20

Table 12. Field Experiment Production and Cost Summary, Later-Maturing Steers on the Deferred Feeding System - 10 Head Average 21

Table 13. Differences in Maintenance Requirements Associated with Metabolic Body Size 23

Table 14. Nutrient Requirements for Growing-Finishing Steer Calves and Yearlings (Daily Nutrients Per Animal) 32

Table 15. Nutrient Requirements for Growing-Finishing Heifer Calves and Yearlings (Daily Nutrients Per Animal). 33

Table 16. Linear Regression Equations Relating Daily Gain and Metabolizable Energy (ME) for Nine Weight Ranges of Traditional Steers. 35

Table 17. Linear Regression Equations Relating Daily Gain and Digestible Protein (DP) for Nine Weight Ranges of Traditional Steers. 36

Table 18. Linear Regression Equations Relating Daily Gain and Metabolizable Energy (ME) for Eight Weight Ranges of Traditional Heifers 37

Table 19. Linear Regression Equations Relating Daily Gain and Digestible Protein (DP) for Eight Weight Ranges of Traditional Heifers 38

Table 20. Dry Matter Intake as Limited by Energy Consumption 43

Table 21. Feedstuff Costs Utilized in the Application of the Simulation Model, Stage I. 48

Table 22. Estimated Price Quotes for Marketable Products 49

Table 23. Simulation Model - Stage I Labeling of Rations 50

Table 24. Simulated Traditional Steer Ration Set; Daily Estimates (Dry Matter Basis) 52

Table 25. Simulated Traditional Heifer Ration Set; Daily Estimates (Dry Matter Basis) 53

Table 26. Outline for Coordinating Backgrounding and Finishing Phases Utilizing the Ration Set Deviloped in Model - Stage I 55

Table 27. Simulation Model - Stage II Production Analysis Equations. 57

Table 28. Simulation Model - Stage II Cost Analysis Equations. 58

Table 29. Summary of Input Values Used in the Cost Analysis Model - Stage II, Traditional Steers and Traditional Heifers. 60

Table 30. Model Ration Set for Evaluation of Traditional "Hamburger" Steer. 64

Table 31. Simulated Feeding System Number 1 - Basis System, Upper Weight Limit of Data Set 65

Table 32. Simulated Feeding System Number 2 - Shortened Finishing Phase. 67

Table 33. Simulated Feeding System Number 3 - Decreased Finishing Weight 68

Table 34. Simulated Feeding System Number 4 - No Backgrounding Phase. 69

Table 35. Simulated Feeding System Number 5 - Increased Purchase Weight. 70

Table 36. Simulated Feeding System Number 6 - Increased Purchase Weight and Shortened Finishing Phase. 71

Table 37. Summary of Production and Cost Data for Six Simulated Feeding Systems (Traditional Steer) 72

Table 38. Simulation Model - Stage II Variable Names (In Order of Use), Description and Units 93

Table 39. Stage II "To Date" and "Period" Production and Cost Analysis of the Stage I Constructed Steer Feeding System 109

Table 40. Stage II "To Date" and "Period" Production and Cost Analysis of the Stage I Constructed Heifer Feeding System 117

Table 41. "To Date" and "Period" Production and Cost Analyses for Simulated Feeding Systems 1 Through 6, "Hamburger" Steer 125

LIST OF FIGURES

Figure 1. Protein and Energy Ratios Related to Daily Gain as Provided by Regression Equations. 40

Figure 2. Probable Relationship Between Energy and Feed Intake and Some Controlling Mechanisms. 41

Figure 3. Simulation Model - Example Matrix 90

Figure 4. Simulation Model - Stage II, Partial Flow Diagram Depicting Print and Ration Selection Procedure 96

Figure 5. Simulation Model - Stage II Complete Computer Program 98

ACKNOWLEDGMENTS

I wish to express my sincere appreciation to Dr. John B. Riley, Associate Professor of Agricultural Economics, for his helpful suggestions and assistance in developing this thesis, as well as the interest expressed, time spent, and guidence extended throughout my graduate program.

I also extend a sincere thanks to Dr. Michael Dikeman for his contributions and assistance in the preparation of this thesis and a thanks to committee members Dr. John McCoy and Dr. Orlan Buller.

To my parents, Mr. and Mrs. Michael R. Myers, I acknowledge my appreciation of their encouragement and assistance throughout my attendance at Kansas State University.

To Miss Jill A. Wingerson I express thanks and appreciation for the many hours spent in the preparation of this thesis and for encouragement extended throughout my graduate studies.

To Bob Heimerman and John Jones, fellow graduate students in agricultural economics, I express appreciation for the friendship extended during our time spent at Kansas State University.

CHAPTER I

INTRODUCTION

Efforts to improve production efficiency have led the cattle feeding industry to further evaluate the performance of a variety of beef breeds and the methods utilized in providing acceptable quality beef products. Interest has centered on the accumulation of performance and carcass data representing many beef breeds and the comparison of different feeding systems. Once performance and carcass data are available beef breeds can be differentiated on the basis of a variety of measurable characteristics and appropriate feeding systems developed to maximize production efficiency.

The U.S. Meat Animal Research Center, U.S. Department of Agriculture, and Kansas State University, Department of Animal Science, have obtained performance, carcass and meat quality data on more than three thousand beef cattle representing seventeen beef breeds or cattle types. Significant differences were found to occur in performance (growth rate, feed efficiency and feed consumption) and carcass composition (retail product, fat trim and bone) between cattle types when slaughtered at similar ages and/or weights with only small differences occuring in meat sensory (tenderness, juciness and flavor) characteristics (USDA, 1976). Similar results were obtained by: Adams et al., 1973; Cole et al., 1964; Hedrick et al., 1970; and Smith et al., 1976.

R. M. Koch found significant differences in growth rate of retail product, fat trim, and bone among steer carcasses obtained after mating

Hereford and Angus cows to Hereford, Angus, Jersey, South Devon, Limousin, Charolais, and Simmental sires, when compared at either a constant age, constant weight or at a constant percentage of fat in the longissimus muscle. Differences in carcass composition were largest when compared at a constant carcass weight and smallest when compared on the basis of fat in the longissimus muscle (Koch et al., 1976). Utilizing 27 crossbred steers (9 Hereford sired, 9 Simmental sired, 9 Limousin sired out of Angus dams), correlation coefficients between carcass chemical composition and palatability, when comparing cattle-types, were found by M. E. Dikeman to be low ($P>.05$) and inconsistent (Dikeman et al., 1975).

The Meat Animal Research Center's and Kansas State University's performance data suggest that later-maturing cattle such as Limousin, Charolais, and Simmental have an advantage in growth rate and carcass leanness at similar ages or weights when managed by the same nutritional regimes. However, performance data provide little information for comparing production efficiency, assuming like quality end products, i.e. products similar in sensory characteristics and quality grade, when different production systems are employed and different cattle types utilized. The objective of this study is to evaluate production efficiency and market acceptability as associated with different cattle-type feeding-system combinations.

A field experiment was constructed to identify and quantify differences in production costs associated with different cattle types and feeding systems. The experiment provided a comparison of like quality end products, i.e. products which upon evaluation resulted in similar meat sensory characteristics and quality grades. Days on feed and subsequent finishing

weights would differ between feeding systems and between cattle types within feeding systems in an attempt to assure like quality and similar meat sensory characteristics for end products.

A two stage simulation model was developed to expand the production and cost analysis of cattle-type feeding-system combinations. The model was based on nutrient level gain response data specific for selected cattle types. Linear programming was utilized in Stage I, the ration formulation stage of the model, to meet the desired model flexibility and provide maximization of the objective function.

Stage I provides the information necessary for constructing feeding systems. Stage II utilizes selected input costs, the constructed feeding systems and nutritional data from Stage I to provide a "to date" and "period" analysis of cost and production factors for each cattle-type feeding-system combination evaluated. Utilization of the model permits multiple comparisons of various cattle-type feeding-system combinations which cannot be as readily made by field trials.

Results of the field trial, the model formulation and selected application of the model are presented in the following chapters. Potential additional applications of the model are also noted.

CHAPTER II

FIELD EXPERIMENT

Experimental Procedure

Two groups of crossbred steers, twenty-four Hereford X Angus (traditional) and twenty-five Simmental sired steers out of either Chianina X Angus or Chianina X Hereford females (later-maturing), were obtained from the U.S. Meat Animal Research Center at Clay Center, Nebraska. The 49 steers were transfered to K.S.U. facilities on November 22, 1977.

Following an adjustment period, each group was alloted by weight to two feeding regimes. Twelve traditional and thirteen later-maturing steers were allocated to an accelerated feeding system. Twelve of each type, traditional and later-maturing, were allocated to a deferred feeding system.

The accelerated feeding system consisted of a four week adjustment period and a subsequent finishing phase (table 1). The length of finishing periods for cattle types differed to facilitate the production of end products similar in quality grade and eating sensory characteristics. The finishing phase was 154 days for the later-maturing accelerated-fed steers, as compared to 112 days for the traditional accelerated-fed steers. Ending target weight for the accelerated-fed traditional steers was 950 pounds. Target weight for the accelerated-fed later-maturing steers was 1100 pounds. Target weights selected to achieve like sensory

TABLE 1. Field Experiment Feeding Systems for Accelerated-Fed Steers

	Traditional Accelerated		Later-Maturing Accelerated	
	Adjustment Phase	Finishing Phase	Adjustment Phase	Finishing Phase
Days on feed	28	112	28	154
Total days on feed	140		182	
	Percent Dry Matter Basis (DMB)			
Corn	57.2	86.0	57.2	85.3
Grain sorghum				
Corn silage	11.8	9.6	11.8	10.4
Grain sorghum silage	25.4		25.4	
Prairie hay				
Protein supplement	5.6	4.4	5.6	4.3
Dry Matter	61.0	79.0	61.0	79.0
Crude protein	10.5	10.8	10.5	10.8
Digestible protein	7.6	8.1	7.6	8.1
	Mega Calories/Lb. Dry Matter (DM)			
Net energy for maintenance	.892	.987	.892	.985
Net energy for gain	.574	.639	.574	.637
Metabolizable energy	1.333	1.435	1.333	1.433
	Dollars			
Ration cost/lb as fed	.034	.048	.034	.047

characteristics were estimated from data presented in Evaluating Germ Plasm for Beef Production, Cycle 1; USDA ARS, 1976.

The deferred feeding system consisted of adjustment, background, and finishing phases (table 2). Following a four week adjustment phase, traditional deferred-fed steers were backgrounded 113 days, whereas later-maturing deferred-fed steers were backgrounded 155 days. Backgrounding periods differed to promote the production of similar end products. Off-feed target weight for the deferred-fed traditional steers was 1150 pounds. Off-feed target weight for the deferred-fed later-maturing steers was 1300 pounds.

Backgrounding rations consisted of approximately 67% prairie hay, 29% grain sorghum, and 4% protein supplement (table 2). Finishing rations contained approximately 84% corn, 12% corn or sorghum silage, and 4% protein supplement (tables 1 and 2).

Bi-weekly weight and average feed consumption were recorded for each cattle type within a given feeding system. All steers were slaughtered at Kansas State University, Department of Animal Science and Industry. The last group to finish, the later-maturing deferred-fed steers were slaughtered on September 25, 1978.[1] Quality and yield grades were determined and recorded. Rib steaks were evaluated for flavor and juiciness by a trained taste panel, and for tenderness by the taste panel and the Warner-Bratzler shear.

Purchase price for all steers was $.70 per pound; trucking charge

---

[1]One later-maturing deferred-fed steer died early in the experiment. A second steer from the same group suffered from a chronic foot ailment. No data were recorded for either steer.

TABLE 2. Field Experiment Feeding Systems for Deferred-Fed Steers

	Traditional Deferred			Later-Maturing Deferred		
	Adj. Phase	Back. Phase	Fin. Phase	Adj. Phase	Back. Phase	Fin. Phase
Days on feed	28	113	117	28	155	123
Total days on feed		258			306	
	---------- Percent Dry Matter Basis (DMB) ----------					
Corn	15.7		82.5	15.7		81.3
Grain sorghum	15.1	29.8		15.1	28.9	
Corn silage			8.0			2.5
Grain sorghum silage	15.9		5.1	15.9		11.8
Prairie hay	48.6	66.3		48.6	67.3	
Protein supplement	4.7	3.9	4.4	4.7	3.8	4.4
Dry matter	75.0	90.0	77.0	75.0	90.0	76.0
Crude protei.	10.2	10.3	10.7	10.2	10.3	10.7
Digestible protein	6.3	5.9	8.0	6.3	5.9	8.0
	---------- Mega Calories/Lb. Dry Matter (DM) ----------					
Net energy for maintenance	.673	.603	.975	.673	.600	.971
Net energy for gain	.287	.192	.631	.287	.187	.628
Metabolizable energy	1.333	.980	1.423	1.064	.976	1.419
	---------- Dollars ----------					
Ration cost/lb. as fed	.037	.037	.050	.037	.037	.049

was $2.00 per head; processing and veterinary charge was $4.50 per head; finished market value was $.65 per pound. On-feed weight included a 2% shrink from purchase weight and pay weight included a 4% pencil shrink from off-feed weight. Feed mark-up at the feedlot was $10.50 per ton; yardage was $.06 per head per day.

Interest rate was 9.5% and was charged on all costs with a line-of-credit granted. A two week billing period was assumed. Interest accumulated in weeks one and two represented interest on purchase costs, trucking and processing charges. The bill for each additional two-week production period included an interest charge for refinancing the previous balance plus additional feed and yardage costs. Interest was not compounded.

Current cash prices for feedstuffs were based on historic farm price relationships represented by the ratio of price of utilized feedstuffs to the price of corn. The feedstuffs/corn price ratios were averaged for the time period, 1970 to 1977 (Kansas Farm Facts, 1970 - 1977). Current feedstuff prices were determined by multiplying derived historic feedstuffs/corn price ratios by the present corn price (price recieved by farmers) (table 3). Handling and markup at the elevator was $.10 per bushel; loading and transportation within two miles was $.05 per bushel; additional transportation was $.01 per bushel per mile. The transportation required was assumed to average 30 miles.

Grain sorghum, alfalfa, prairie hay, and the soybean meal in the protein supplement were priced in the above manner. Vitamin A, minerals, fat, and urea were also supplied by the protein supplement with the associated costs added in determining the cost of the supplement. Cost of

TABLE 3. Historic Feedstuff/Corn Price Ratios, Kansas 1970 - 1977

Feedstuff	Ratio	Ratio Units
Corn	1.00	bu./bu.
Grain sorghum	.87	bu./bu.
Soybean meal	4.96	cwt./bu.
Prairie hay	17.68	ton/bu.

Example:

Corn: present corn price	$2.20	/bu.	recieved by farmer
	.10	/bu.	handling and markup
	.05	/bu.	loading and transportation
	.28	/bu.	transportation
	$2.63	/bu.	at feedlot

$2.63 per bu./56 lbs. per bu. =	$ .04969	/lb.	
	.00525	/lb.	markup at feedlot ($10.50/ton)
	$ .05221	/lb.	as fed (AF)

Commodity price = (present corn price) * (historic price ratio, 1970 - 77)

Grain sorghum: ($2.20)*(.87) =	$1.91	/bu.	recieved by farmers
	.10	/bu.	handling and markup
	.05	/bu.	loading and transportation
	.28	/bu.	transportation
	$2.34	/bu.	at feedlot

$2.34 per bu./56 lbs. per bu. =	$ .04179	/lb.	
	.00525	/lb.	markup at feedlot ($10.50/ton)
	$ .04704	/lb.	as fed (AF)

transporting and grinding the alfalfa and prairie hay was $8.00 per ton.

The pricing of corn and sorghum silage assumed a yeild of 18 tons of silage per acre from a crop estimated to have had the ability to provide 125 bu. of corn per acre. Cutting, transportation, and packing cost were $8.00 per ton. A summary of feedstuff prices is provided in (table 4).

TABLE 4. Derived Prices for Feedstuffs

Feedstuff	Dollars Per Lb. As Fed
Corn	$.05221
Grain sorghum	$.04704
Protein supplement	$.10390
Prairie hay	$.02870
Corn silage	$.01689
Grain sorghum silage	$.01689

Corn and grain sorghum silage:

$$\text{Price of silage} = \frac{(\text{price of corn/bu.}) * (125 \text{ bu./acre})}{18 \text{ tons/acre}} = \$15.28/\text{ton}$$

$15.28/ton
8.00/ton cutting, transportation and packing
$23.28/ton at feedyard

$23.80 per ton/2000 lbs. per ton = $.01164/lb.
.00525/lb. markup at the feedlot
$.01689/lb. as fed (AF)

Results and Discussion

Large differences were found in production costs as measured for cattle types, feeding systems, and cattle-type feeding-system combinations. However, only small differences were found when meat sensory characteristics (tenderness, juiciness, and flavor) were compared for the above groupings.

Meat Sensory Characteristics and Quality Grades

Rib steaks from steers on the accelerated feeding system and from those on the deferred feeding system were judged of equal flavor by a trained taste panel, and equally tender by the Warner-Bratzler shear, even though steers on the accelerated feeding system had lower quality grades. Round steaks were more ($P<.05$) tender and more ($P<.05$) flavorful on the accelerated feeding system as compared to the deferred feeding system.

Feeding Systems

The accelerated feeding system provided the lowest total cost of gain; total cost of gain for all accelerated steers averaged $.4285 per pound as compared to $.5519 per pound for all deferred-fed steers. Daily gains averaged 2.89 pounds for accelerated-fed steers and 2.38 pounds for deferred-fed steers. Average yardage and interest costs per pound of gain were less for accelerated-fed steers; yardage cost per pound of gain averaged $.0208 for all accelerated-fed steers and $.0253 for all deferred-fed steers. Interest cost for accelerated-fed steers averaged $.0445 per pound of gain as compared to $.0589 for deferred-fed steers.

Deferred-fed steers consumed greater daily quantities of dry matter averaging 22 pounds per head per day as opposed to the 17.6 pounds consumed by accelerated-fed steers. Average earnings provided by all accelerated-fed steers were $34.59 per head as compared to $-10.15 per head for all deferred-fed steers (tables 5 and 6).

Cattle Types

Comparing cattle types, total cost per pound of gain for all later-maturing steers averaged $.4935 per pound as compared to $.5004 per pound for traditional steers. Average daily gain was greater for later-maturing steers at 2.68 pounds per head per day in contrast to the average of 2.46 pounds gained per head per day by the traditional steers. Average yardage and interest costs were less per pound of gain for later-maturing steers than for traditional steers. Daily dry matter consumption averaged 1.8 pounds per head per day greater for later-maturing steers, at 21.1 pounds. Earnings for all later-maturing steers averaged $24.98 per head while returns for all traditional steers averaged $2.64 per head (tables 7 and 8).

Feeding Systems and Cattle Type Combinations

The combination of feeding system and cattle type, that resulted in the lowest average total cost per pound of gain was that of the later-maturing accelerated-fed steers at $.4149 per pound. Total cost per pound of gain was greatest for later-maturing deferred-fed steers at an average of $.5698 per pound. Average daily gain was greatest for later-maturing accelerated-fed steers at 3.03 pounds per head per day. The lowest average daily gains were provided by the traditional deferred-fed steers at 2.34

TABLE 5. Field Experiment Production and Cost Summary, All Accelerated-Fed Steers - 25 Head Average

	Adjustment Phase	Finishing Phase	Total Feeding Period
Days	28	133	161
	Pounds		
Beginning weight	567	646	567
Ending weight	646	1033	1033
Gain	79	387	466
Average daily gain	2.82	2.91	2.89
Dry matter consumed/day	17.0	17.7	17.6
	Pounds Dry Matter		
Conversion (feed/lb. gain)	6.03	6.08	6.08
	Percent		
Feed consumption required for maintenance	34.38	38.32	37.79
	Dollars		
Cost of feed/lb. gain	.3383	.3650	.3605
Cost of yardage/lb. gain	.0213	.0208	.0208
Cost of interest/lb. gain	.0387	.0457	.0445
Total cost/lb. gain	.3983	.4315	.4258
Quality grade[a]			8.2
Percent choice			24.0
Yield grade			2.8
Value: (4% pencil shrink)			$644.61
Less: Purchase, processing and trucking costs			411.61
Feed, yardage and interest costs			198.41
Earnings/head			$ 34.59

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

TABLE 6. Field Experiment Production and Cost Summary, All Deferred-Fed Steers - 22 Head Average

	Adj. Phase	Back. Phase	Finishing Phase	Total Feeding Period
Days	28	132	119	279
	Pounds			
Beginning weight	568	646	794	568
Ending weight	646	794	1232	1232
Gain	78	148	438	664
Average daily gain	2.79	1.12	3.68	2.38
Dry matter consumed/day	16.3	19.9	25.6	22.0
	Pounds Dry Matter			
Conversion (feed/lb. gain)	5.84	17.80	6.96	9.24
	Percent			
Feed consumption required for maintenance	47.48	48.74	30.77	40.37
	Dollars			
Cost of feed/lb. gain	.2642	.7336	.4127	.4668
Cost of yardage/lb. gain	.0215	.0536	.0164	.0253
Cost of interest/lb. gain	.0391	.1115	.0463	.0598
Total cost/lb. gain	.3248	.8987	.4754	.5519
Quality grade[a]				9.5
Percent choice				63.6
Yield grade				3.4
Value (4% pencil shrink)				$768.76
Less: Purchase, processing and trucking costs				412.34
Feed, yardage and interest costs				366.57
Earnings/head				$-10.15

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

TABLE 7. Field Experiment Production and Cost Summary, All Traditional Steers - 24 Head Average

	Adj. Phase	Back. Phase	Finishing Phase	Total Feeding Period
Days	28	113	114	199
			Pounds	
Beginning weight	570	638	701	570
Ending weight	643	755	1059	1059
Gain	73	117	358	489
Average daily gain	2.61	1.03	3.14	2.46
Dry matter consumed/day	16.8	17.8	20.7	19.3
			Pounds Dry Matter	
Conversion (feed/lb. gain)	6.44	17.30	6.59	7.84
			Percent	
Feed consumption required for maintenance	39.70	53.70	34.00	40.00
			Dollars	
Cost of feed/lb. gain	.3270	.7208	.3920	.4214
Cost of yardage/lb. gain	.0230	.0583	.0191	.0244
Cost of interest/lb. gain	.0420	.1186	.0470	.0546
Total cost/lb. gain	.3920	.8977	.4581	.5004
Quality grade[a]				5.3
Percent choice				54.2
Yield grade				3.5
Value: (4% pencil shrink)				$660.79
Less: Purchase, processing and trucking costs				413.48
Feed, yardage and interest costs				244.67
Earnings/head				$ 2.64

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

TABLE 8. Field Experiment Production and Cost Summary, All Later-maturing Steers - 23 Head Average

	Adj. Phase	Back. Phase	Finishing Phase	Total Feeding Period
Days	28	155	140	235
			Pounds	
Beginning weight	566	656	730	566
Ending weight	649	842	1196	1196
Gain	83	186	466	630
Average daily gain	2.96	1.20	3.33	2.68
Dry matter consumed/day	16.5	21.7	21.6	21.1
			Pounds Dry Matter	
Conversion (feed/lb. gain)	5.57	18.10	6.49	7.87
			Percent	
Feed consumption required for maintenance	39.70	46.90	34.43	39.02
			Dollars	
Cost of feed/lb. gain	.2874	.7438	.3863	.4191
Cost of yardage/lb. gain	.0202	.0500	.0181	.0225
Cost of interest/lb. gain	.0366	.1063	.0454	.0519
Total cost/lb. gain	.3442	.9000	.4498	.4935
Quality grade[a]				8.5
Percent choice				34.8
Yield grade				2.5
Value: (4% pencil shrink)				$746.33
Less: Purchase, processing and trucking costs				410.36
Feed, yardage and interest costs				310.99
Earnings/head				$ 24.98

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

pounds. Average yardage cost per pound of gain was the lowest for the later-maturing accelerated-fed steers at $.0199, and the highest at $.0256 for traditional deferred-fed steers. The lowest average interest cost per pound of gain, $.0430, resulted from the later-maturing accelerated-fed steers, the highest, $.0608, from the later-maturing deferred-fed steers. Later-maturing deferred-fed steers consumed the most dry matter per head per day. These steers consumed an average of 23.4 pounds of dry matter per head per day. Traditional accelerated-fed steers consumed an average of 17 pounds per head per day, the lowest consumption of all four groups. Average earnings for each cattle-type feeding-system combination were: $57.76 per head for later-maturing accelerated-fed steers, $9.90 per head for traditional accelerated-fed steers, $-4.01 for traditional deferred-fed steers, and $-17.81 for later-maturing deferred-fed steers (tables 9, 10, 11, 12).

Important Cost and Production Factors

Several important cost and production factors were identified when comparing production and cost data.

Yardage. Since yardage costs represent a fixed daily charge, yardage costs per pound of gain varies inversely and proportionately with variations in average daily gain.

Interest. Interest cost per pound of gain is a function of acquisition cost (purchase, trucking, and processing costs) and feed cost. Assuming a constant rate of gain, interest cost per pound of gain will increase through the production period due to accumulated feed costs.

Maintenance Requirements for Energy as a Percent of Consumption. Deferred-fed steers consumed 25.6 pounds of dry matter per head per day

TABLE 9. Field Experiment Production and Cost Summary, Traditional Steers on the Accelerated Feeding System - 12 Head Average

	Adjustment Phase	Finishing Phase	Total Feeding Period
Days	28	112	140
		Pounds	
Beginning weight	572	648	572
Ending weight	648	947	947
Gain	76	299	375
Average daily gain	2.73	2.68	2.69
Dry matter consumed/day	17.0	17.0	17.0
		Pounds Dry Matter	
Conversion (feed/lb. gain)	5.60	6.10	6.00
		Percent	
Feed consumption required for maintenance	34.50	38.10	37.50
		Dollars	
Cost of feed/lb. gain	.3494	.3804	.3741
Cost of yardage/lb. gain	.0220	.0225	.0224
Cost of interest/lb. gain	.0402	.0485	.0468
Total cost/lb. gain	.4116	.4514	.4433
Quality grade[a]			8.7
Percent choice			25.0
Yield grade			3.3
Value: (4% pencil shrink)			$590.80
Less: Purchase, processing and trucking costs			414.62
Feed, yardage and interest costs			166.28
Earnings/head			$ 9.90

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

TABLE 10. Feild Experiment Production and Cost Summary, Later-Maturing Steers on the Accelerated Feeding System - 13 Head Average

	Adjustment Phase	Finishing Phase	Total Feeding Period
Days	28	154	182
		Pounds	
Beginning weight	563	645	563
Ending weight	645	1113	1113
Gain	32	468	550
Average daily gain	2.90	3.05	3.03
Dry matter consumed/day	17.0	18.2	18.0
		Pounds Dry Matter	
Conversion (feed/lb. gain)	5.30	5.70	5.70
		Percent	
Feed consumption required for maintenance	34.30	38.40	38.00
		Dollars	
Cost of feed/lb. gain	.3296	.3559	.3520
Cost of yardage/lb. gain	.0207	.0197	.0199
Cost of interest/lb. gain	.0374	.0440	.0430
Total cost/lb. gain	.3877	.4196	.4149
Quality grade[a]			8.0
Percent choice			23.1
Yield grade			2.3
Value: (4% pencil shrink)			$694.66
Less: Purchase, processing and trucking costs			408.84
Feed, yardage and interest costs			228.06
Earnings/head			$ 57.76

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

TABLE 11. Field Experiment Production and Cost Summary, Later-Maturing Steers on the Accelerated Feeding System - 13 Head Average

	Adj. Phase	Back. Phase	Finishing Phase	Total Feeding Period
Days	28	113	117	258
			Pounds	
Beginning weight	568	638	755	568
Ending weight	638	755	1172	1172
Gain	70	117	417	604
Average daily gain	2.50	1.03	3.58	2.34
Dry matter consumed/day	16.7	17.8	24.2	20.6
			Pounds Dry Matter	
Conversion (feed/lb. gain)	6.40	17.40	6.50	8.60
			Percent	
Feed consumption required for maintenance	46.30	53.70	31.30	41.40
			Dollars	
Cost of feed/lb. gain	.3002	.7208	.4001	.4503
Cost of yardage/lb. gain	.0240	.0583	.0167	.0256
Cost of interest/lb. gain	.0436	.1186	.0454	.0593
Total cost/lb. gain	.3678	.8977	.4622	.5352
Quality grade[a]				9.8
Percent choice				83.3
Yield grade				4.0
Value: (4% pencil shrink)				$731.39
Less: Purchase, processing and trucking costs				412.34
Feed, yardage and interest cost				323.06
Earnings/head				$ -4.01

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

TABLE 12. Field Experiment Production and Cost Summary, Later-Maturing Steers on the Deferred Feeding System - 10 Head Average

	Adj. Phase	Back. Phase	Finishing Phase	Total Feeding Period
Days	28	155	123	306
			Pounds	
Beginning weight	568	656	842	568
Ending weight	656	842	1303	1303
Gain	88	186	461	735
Average daily gain	3.11	1.20	3.77	2.41
Dry matter consumed/day	16.0	21.7	27.2	23.4
			Pounds Dry Matter	
Conversion (feed/lb. gain)	4.90	18.10	6.90	9.50
			Percent	
Feed consumption required for maintenance	48.90	46.90	30.30	39.70
			Dollars	
Cost of feed/lb. gain	.2308	.7438	.4271	.4840
Cost of yardage/lb. gain	.0193	.0500	.0160	.0250
Cost of interest/lb. gain	.0349	.1063	.0474	.0608
Total cost/lb. gain	.2850	.9000	.4850	.5698
Quality grade[a]				9.1
Percent choice				50.0
Yield grade				4.0
Value: (4% pencil shrink)				$813.32
Less: Purchase, processing and trucking costs				412.34
Feed, yardage and interest cost				418.79
Earnings/head				$-17.81

[a]Quality grade: 15, 14, 13 = Prime; 12, 11, 10 = Choice; 9, 8, 7 = Good; 6, 5, 4 = Standard

during the finishing phase as compared to the 17.7 pounds of dry matter consumed per day by the accelerated-fed steers. Energy and protein content were similar for all finishing rations. For all deferred-fed steers, 30.8% of the finishing ration was required to provide maintenance energy, while 38.3% of the finishing ration fed accelerated steers was required to meet maintenance requirements for energy.[2] If deferred-fed steers had consumed only 17.7 pounds of dry matter per head per day during the finishing period, as did the accelerated-fed steers, 44.5% of the finishing ration would have been required for maintenance. This difference, 38.3% as compared to 44.5%, is a good indication of the difference in maintenance energy requirements resulting from weight differences between cattle types during the finishing phase (table 13).

As noted, increased dry matter consumption reduces the percent of total feed consumption required for maintenance. However, the maintenance comparison assumes that animals are at a similar physiological state. On-feed weights differed for the finishing phases between feeding systems. The average weight for accelerated-fed steers placed on the finishing ration was 646 pounds per head, while the average weight for placing deferred-fed steers on the finishing ration was 795 pounds. Off-feed weight also differed as accelerated-fed steers finished at an average weight of 1033 pounds per head and deferred-fed steers finished at an

---

[2]Maintenance computations assume production within the thermal neutral zone. Such computations facilitate comparisons, however any divergence (+ or -) from the zone will result in an increased maintenance requirement for energy. Temperatures were known to have been outside the thermal neutral zone at certain times for all groups tested.

TABLE 13. Differences in Maintenance Requirements Associated with Metabolic Body Size

	Accelerated-Fed Steers	Deferred-Fed Steers
Average weight (kg.)	380.97	459.52
Mega calories (mcals.) net energy required for maintenance[a]	6.64	7.64
Net energy for maintenance per lb. dry matter - finishing ration (mcals.)	.986	.973
Lbs. of dry matter required for maintenance	6.64/.986 = 6.73	7.64/.973 = 7.85
% of dry matter required for maintenance	6.73/17.7 = .3802 (38.02%)	7.85/17.7 = .4435 (44.35%)

[a] $NE_m = 0.077 Wkg.^{.75}$ (Lofgreen, 1968)

Where: NE_m = Net energy for maintenance (mcals.)

Wkg. = Body weight (kilograms)

$Wkg.^{.75}$ = Metabolic body size (Garrett, 1959)

average weight of 1232 pounds per head. Thus, the advantage of increased consumption during the finishing phase for deferred-fed steers was greatly offset by a physiologically less efficient production period and their larger relative metabolic body size which resulted in a greater maintenance energy requirement. Any feeding phase requiring a high percent of consumption to supply energy for maintenance needs should be avoided, or when necessary, its duration minimized.

Backgrounding. The production process, due to a time limited finishing phase, may require that a restricted backgrounding phase be incorporated with the finishing phase to produce the desired end weight and quality grade. Restraints on the backgrounding ration reflect an attempt to control the animal weight and degree of finish as desired for incorporation into the finishing program.

Desired weights, quality grades, and sensory characteristics were achieved without the use of a backgrounding phase for accelerated-fed steers. Data suggest that no stalling due to an extended finishing phase, disenchantment with surrounding, or excessive finish had occured on the accelerated feeding system. Feed consumption had not faltered nor had the feed required per pound of gain became excessive. Both the accelerated and deferred feeding systems utilized steers of similar backgrounds and similar weights. Comparison of the accelerated and deferred feeding systems indicated the significance of backgrounding periods which may be too long or unnecessary. During the backgrounding phase, 49.74% of feed consumed by deferred-fed steers was required for maintenance needs. The backgrounding phase was 42 days longer for later-maturing deferred-fed steers as compared to traditional deferred-fed steers. This extended

backgrounding phase with its low rate of gain, high maintenance requirement as a percentage of consumption, and resulting high cost of gain was a major factor in preventing the later-maturing deferred-fed steers from out performing the traditional deferred-fed steers in all production and cost efficiency measures.

Ration Content. Little data are available relating nutrient requirements for progressive stages in the growth of later-maturing steers used in the trial. Even so, ration content and production data suggest that each cattle type may not have recieved a specific optimum mix of nutrients. If dry matter consumption and nutrient content of the ration are nearly equal while the composition of the gain (retail product, fat and bone) between cattle types differ, then some nutrient imbalance must exist for one or both cattle types when this ration is fed. Different gains between cattle types, while dry matter consumption and the nutritive content of the ration were identical, would indicate that the necessary nutrients were available to support the greater gains. Daily gain for the one cattle type being lower, some nutrients would have been oversupplied to these steers and feed costs would have been greater than necessary in producing the resulting gains.

Maturity Differences Associated with Cattle Types. If both cattle types, traditional and later-maturing, were placed on feed at the same weight, fed in a specific optimum manner, removed from feed at equal efficiency (feed cost/lb. gain) endpoints, yielding like end products, the later-maturing steers would have gained more pounds. Since end point efficiency is assumed to be equal for both cattle types, end weights between cattle types will differ and the later-maturing steers will have

accumulated more pounds stemming from equally, or more efficient production periods. Once information of this type is available, price differentials can be determined relating the appropriate purchase price for different feeder cattle types.

It should be noted that by placing both cattle types on feed at an equivalent weight, the expected efficiency of the traditional steers will be inferior to that of later-maturing steers at the beginning of the production period. This disadvantage could be offset by placing the traditional steers on feed at a lighter weight to provide identical beginning and ending efficiency endpoints as well as like end products for both traditional and later-maturing cattle types. However, the later-maturing steers could also be placed on feed at the lighter weight which restores their advantage, as previously stated, as there is no indication that one cattle type is superior in its ability to be placed on feed at a lighter weight, or that either cattle type is superior in maintaining high production levels during an extended finishing phase. Later-maturing steers, when finished to the same end point efficiency measured in feed cost per pound of gain, supplied more pounds of a product judged to have equally acceptable flavor, juciness, and tenderness, and a similar quality grade.

As on-feed weights are pushed lower, backgrounding or growing rations are required; consequently backgrounding and finishing phases must be carefully coordinated. The time requirement for finishing the lighter calves must also be considered. While the use of the lighter calves may result in higher profits per head, it is possible that greater profits could be realized by the finishing of heavier steers requiring shorter

production periods. While profit per head for the heavier steers would likely be less than that provided by the lighter steers, profit per unit time may be greater.

Breed Crosses Associated with Cattle Types. The later-maturing steers were three-eights blood traditional steers. Without the influence of the cross, the later-maturing steers may not have met the resulting quality standards, and possibly not have met the meat sensory characteristics, at the efficiency endpoint indicated in the results of the trial. Thus the later-maturing steers may not have out performed the traditional steers for evaluated characteristics, without the aid of the traditional cattle type influence.

Summary

The field experiment indicated several important cost and production factors affecting the total cost of production. These factors can be summarized as follows:

1) Yardage cost per pound of gain varies indirectly and proportionately with rate of gain.
2) Interest cost per pound of gain varies according to rate of gain and the cost of the feed required to produce that gain.
3) Backgrounding and finishing phases of production should be coordinated to avoid any unnecessary backgrounding and potentially inefficient gains. (Energy and protein requirements for maintenance exert a large influence on production efficiency.)
4) The continued maintenance of maximum consumption will minimize maintenance requirements as a percentage of consumption for any

given feeding situation.

5) Different cattle types should be supplied rations that are cattle-type as well as production-phase specific in providing the optimum nutrient balance, and the nutrient balance should be that required to provide the optimum rate of gain.

6) The selected nutrient mix should be provided on a least cost basis if production cost analyses and cost comparisons are desired.

CHAPTER III

SIMULATION MODEL

Introduction

As acquisition costs, feed costs, interest costs and market prices change, and the demand for livestock products shifts, it is benefical to compare cattle types (e.g. steers versus heifers, traditional versus later-maturing), feeding systems (accelerated versus deferred, light versus heavy placement, high roughage versus high concentrate), and combinations of cattle types and feeding systems. A simulation model was developed to provide further production and cost analyses of cattle types and feeding systems. The simulation model is flexible enough to accommodate various cattle-type feeding-system combinations.

In comparing or evaluating cost and production data for cattle types in combination with feeding systems, comparisons and evaluations must be made assuming an optimum profit maximizing system for each cattle-type feeding-system combination. The comparison of non-optimized management systems is of little use, as there is usually neither the incentive to repeat the procedure in commercial production nor the incentive to utilize information from resulting production and/or cost data.

To provide the desired flexibility and the desired basis for comparison the simulation model has two stages. Stage I of the model determines the combination of feedstuffs that will result in the optimum rate of gain for progressive stages in the growth of the selected cattle type.

This stage supplies the production data required to construct feeding systems. Stage II provides a cost and production analysis, basesd on the rations formulated and feeding system constructed in stage I.

Model - Stage I

Linear programming has traditionally been utilized in formulating least cost feed rations. Initial data for ration formulations require a selected rate of gain and the nutrient requirements associated with that gain, a set of available feedstuffs, nutrient analysis and costs of the feedstuffs, associated and/or desired restrictions, and an estimate of feed intake. Any feedstuff for which the required nitrient analysis, associated restrictions, and cost estimates are available can be placed in the linear programming matrix for evaluation and possible inclusion in the selected ration. When formulated in this manner, feed rations provide the least cost combination of available feedstuffs required to meet the appropriate growth phase nutrient requirements associated with a specified rate of gain. Not considered is the value of the gain or product produced. The value of the marketable product reflects the quantity and quality of the product as determined by the particular production or growth phase of the animal and the ration fed. Value must be considered in relation to production costs if returns are to be determined (returns = production value - variable costs). Unsolved, however, is the optimum rate of production, i.e. the rate of daily gain which results in maximum returns, given consideration of production cost and market value.

Stage I of the simulation model transforms nutritional data into a form sutiable for inclusion into a linear programming matrix with the end result being the selection of the rate of daily gain and feed ration which maximizes returns. Resulting rates of gain and rations formulated, as restricted for specific uses and/or representing varying stages of the animals growth, are used in the construction of feeding systems. Linear programming in Stage I provides flexibility in that maximum and minimum restrictions can be placed on dry matter intake, metabolizable energy intake, the utilization of individual feedstuffs, total concentrates, total roughages, and rate of gain. Given optimum results under specified restrictions particular to cattle types, a basis is provided on which valid comparisons between cattle types can be made. The model provides a means of evaluating cattle types and/or feeding systems, holding other variables constant.

Model Formulation

Nutrients and Nurtient Requirements. Nutrient requirements utilized in the formulation of rations were determined from field trials and reported for use with similar cattle types as shown in tables 14 and 15 (NRC, 1976 p. 22)[3]. These tables indicate applicable weight ranges or feeding periods represented by the average weight for the range with nine ranges provided for traditional steers and eight for traditional heifers. Different weight ranges provide for adjustments in nutrient

---

[3]The simulation model identifies steers and heifers of traditional breeds as different cattle types, as opposed to the field experiment where traditional breeds and later-maturing breeds were identified as different cattle types.

TABLE 14. Nutrient Requirements for Growing-Finishing Steer Calves and and Yearlings (Daily Nutrients Per Animal)

Weight[a]		Daily Gain		Minimum Dry Matter Consumption[b]		Roughage[b]	Total Protein	Digestible Protein	NE_m	NE_g	ME[b]	TDN[b,c]		Ca	P	Vitamin A (Thousands
(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(%)	(kg)	(kg)	(Mcal)	(Mcal)	(Mcal)	(kg)	(lb)	(g)	(g)	IU)
100	220	0	0	2.1	4.6	100	0.18	0.10	2.43	0	4.2	1.2	2.6	4	4	5
		0.5	1.1	2.9	6.4	70–80	0.36	0.24	2.43	0.89	6.6	1.8	4.0	14	11	6
165 lbs.		0.7	1.5	2.7	6.0	50–60	0.40	0.28	2.43	1.27	7.1	2.0	4.4	19	13	6
to		0.9	2.0	2.8	6.2	25–30	0.46	0.33	2.43	1.68	7.7	2.1	4.6	24	16	7
275 lbs.		1.1	2.4	2.7	6.0	15	0.49	0.36	2.43	2.10	8.4	2.3	5.1	28	19	7
150	331	0	0	2.8	6.2	100	0.23	0.13	3.30	0	5.6	1.6	3.5	5	5	6
		0.5	1.1	4.0	8.8	70–80	0.44	0.28	3.30	1.20	9.0	2.5	5.5	14	12	9
276 lbs.		0.7	1.5	3.9	8.6	50–60	0.49	0.33	3.30	1.73	9.6	2.7	6.0	18	14	9
to		0.9	2.0	3.8	8.4	25–30	0.54	0.37	3.30	2.27	10.7	3.0	6.6	23	17	9
385 lbs.		1.1	2.4	3.7	8.2	15	0.58	0.41	3.30	2.84	11.3	3.1	6.8	28	20	9
200	441	0	0	3.5	7.7	100	0.30	0.17	4.10	0	7.0	1.9	4.2	6	6	8
		0.5	1.1	5.8	12.8	80–90	0.57	0.35	4.10	1.49	12.1	3.4	7.5	14	13	12
386 lbs.		0.7	1.5	5.7	12.6	70–80	0.61	0.39	4.10	2.14	13.0	3.6	7.9	18	16	13
to		0.9	2.0	4.9	10.8	35–45	0.61	0.40	4.10	2.82	13.3	3.7	8.2	23	18	13
495 lbs.		1.1	2.4	4.6	10.1	15	0.63	0.43	4.10	3.52	14.1	3.9	8.6	27	20	13
250	551	0	0	4.4	9.7	100	0.35	0.20	4.84	0	8.2	2.3	5.1	8	8	9
		0.7	1.5	5.8	12.8	55–65	0.62	0.39	4.84	2.53	14.4	4.0	8.8	18	16	14
496 lbs.		0.9	2.0	6.2	13.7	45–50	0.69	0.44	4.84	3.33	16.2	4.5	9.9	22	19	14
to		1.1	2.4	6.0	13.2	20–25	0.73	0.48	4.84	4.17	17.0	4.7	10.4	26	21	14
606 lbs.		1.3	2.9	6.0	13.2	15	0.76	0.51	4.84	5.04	18.6	5.2	11.5	30	23	14
300	661	0	0	4.7	10.4	100	0.40	0.23	5.55	0	9.4	2.6	5.7	9	9	10
		0.9	2.0	8.1	17.9	55–65	0.81	0.50	5.55	3.82	19.5	5.4	11.9	22	19	16
607 lbs.		1.1	2.4	7.6	16.8	20–25	0.82	0.52	5.55	4.78	20.4	5.6	12.3	25	22	16
to		1.3	2.9	7.1	15.6	15	0.83	0.54	5.55	5.77	21.6	6.0	13.2	29	23	16
717 lbs.		1.4[d]	3.1	7.3	16.1	15	0.87	0.57	5.55	6.29	22.5	6.2	13.7	31	25	16
350	772	0	0	5.3	11.7	100	0.46	0.26	6.24	0	10.6	2.9	6.4	10	10	12
		0.9	2.0	8.0	17.6	45–55	0.80	0.49	6.24	4.29	20.8	5.8	12.8	20	18	18
718 lbs.		1.1	2.4	8.0	17.6	20–25	0.83	0.52	6.24	5.36	22.4	6.2	13.7	23	20	18
to		1.3	2.9	8.0	17.6	15	0.87	0.55	6.24	6.48	24.2	6.8	15.0	26	22	18
827 lbs.		1.4[d]	3.1	8.2	18.1	15	0.90	0.57	6.24	7.06	25.3	7.0	15.4	28	24	18
400	882	0	0	5.9	13.0	100	0.51	0.29	6.89	0	11.8	3.3	7.3	11	11	13
		1.0	2.2	9.4	20.7	45–55	0.87	0.54	6.89	5.33	24.5	6.8	15.0	21	20	19
828 lbs.		1.2	2.6	8.5	18.7	20–25	0.87	0.54	6.89	6.54	25.4	7.0	15.4	23	21	19
to		1.3	2.9	8.6	19.0	15	0.90	0.56	6.89	7.16	26.5	7.3	16.1	25	22	19
937 lbs.		1.4[d]	3.1	9.0	19.8	15	0.94	0.59	6.89	7.80	28.0	7.7	17.0	26	23	19
450	992	0	0	6.4	14.1	100	0.54	0.31	7.52	0	12.8	3.6	—	12	12	14
		1.0	2.2	10.3	22.7	45–55	0.96	0.57	7.52	5.82	26.7	7.4	16.3	20	20	20
938 lbs.		1.2	2.6	10.2	22.5	20–25	0.97	0.58	7.52	7.14	28.6	7.9	17.4	23	22	20
to		1.3	2.9	9.3	20.5	15	0.97	0.59	7.52	7.83	29.0	8.0	17.6	24	23	20
1047 lbs.		1.4[d]	3.1	9.8	21.6	15	0.98	0.60	7.52	8.52	30.5	8.4	18.5	25	23	20
500	1,102	0	0	7.0	15.4	100	0.60	0.34	8.14	0	13.9	3.8	8.4	13	13	15
		0.9	2.0	10.5	23.1	45–55	0.95	0.56	8.14	5.60	27.1	7.5	16.5	19	19	23
1048 lbs.		1.1	2.4	10.4	22.9	20–25	0.96	0.57	8.14	7.01	29.2	8.1	17.8	20	20	23
to		1.2	2.6	9.6	21.2	15	0.96	0.58	8.14	7.73	29.7	8.2	18.1	21	21	23
1157 lbs.		1.3[d]	2.9	10.0	22.0	15	0.97	0.60	8.14	8.47	31.4	8.7	19.2	22	22	23

[a] Average weight for a feeding period.
[b] Dry matter consumption, ME and TDN allowances are based on NE requirements and the general types of diet indicated in the roughage column. Most roughages will contain 1.9–2.2 Mcal of ME/kg dry matter and 90–100% concentrate diets are expected to contain 3.1–3.3 Mcal of ME/kg.
[c] TDN was calculated by assuming 3.6155 Mcal of ME per kg of TDN.
[d] Most steers of the weight indicated, and not exhibiting compensatory growth, will fail to sustain the energy intake necessary to maintain this rate of gain for an extended period.

SOURCE: NRC, 1976.

TABLE 15. Nutrient Requirements for Growing-Finishing Heifer Calves and Yearlings (Daily Nutrients Per Animal)

Weight[a]		Daily Gain		Minimum Dry Matter Consumption[b]		Roughage[b]	Total Protein	Digestible Protein	NE_m	NE_g	ME[b]	TDN[b,c]		Ca	P	Vitamin A (Thousands
(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(%)	(kg)	(kg)	(Mcal)	(Mcal)	(Mcal)	(kg)	(lb)	(g)	(g)	IU)
100	220	0	0	2.1	4.6	100	0.18	0.10	2.43	0	4.2	1.2	2.6	4	4	5
165 lbs.		0.5	1.1	3.0	6.6	70–80	0.37	0.25	2.43	0.99	6.9	1.9	4.2	14	11	6
to		0.7	1.5	2.9	6.4	50–60	0.42	0.29	2.43	1.44	7.5	2.1	4.6	19	14	6
275 lbs.		0.9	2.0	3.0	6.6	25–30	0.48	0.34	2.43	1.92	8.3	2.3	5.1	24	17	7
		1.1	2.4	3.0	6.6	<15	0.53	0.39	2.43	2.43	9.2	2.5	5.5	29	19	7
150	331	0	0	2.8	6.2	100	0.24	0.14	3.30	0	5.6	1.6	3.5	5	5	6
276 lbs.		0.5	1.1	4.1	9.0	70–80	0.45	0.29	3.30	1.34	9.4	2.6	5.7	14	12	9
to		0.7	1.5	4.0	8.8	50–60	0.50	0.33	3.30	1.95	10.4	2.8	6.2	18	14	9
385 lbs.		0.9	2.0	4.0	8.8	25–30	0.54	0.37	3.30	2.60	11.3	3.1	6.8	23	17	9
		1.1	2.4	4.0	8.8	<15	0.60	0.42	3.30	3.30	12.4	3.4	7.5	28	20	9
200	441	0	0	3.5	7.7	100	0.30	0.17	4.10	0	7.0	1.9	4.2	6	6	8
386 lbs.		0.3	0.7	5.4	11.9	100	0.49	0.29	4.10	0.95	10.8	3.0	6.6	10	10	12
to		0.5	1.1	6.0	13.2	80–90	0.58	0.35	4.10	1.66	12.7	3.5	7.7	14	13	13
495 lbs.		0.7	1.5	6.0	13.2	70–80	0.61	0.39	4.10	2.42	13.8	3.8	8.4	18	16	13
		0.9	2.0	5.3	11.7	35–45	0.62	0.40	4.10	3.23	14.3	4.0	8.8	22	17	13
		1.1	2.4	5.0	11.0	<15	0.64	0.43	4.10	4.09	15.4	4.3	9.5	25	19	13
250	551	0	0	4.1	9.0	100	0.35	0.20	4.84	0	8.3	2.3	5.1	7	7	9
496 lbs.		0.3	0.7	6.4	14.1	100	0.57	0.33	4.84	1.13	12.8	3.5	7.8	12	12	14
to		0.5	1.1	6.5	14.3	80–90	0.62	0.37	4.84	1.96	14.2	3.9	8.6	13	13	14
606 lbs.		0.7	1.5	5.8	12.8	55–65	0.62	0.36	4.84	2.86	15.0	4.1	9.1	17	15	14
		0.9	2.0	5.9	13.0	35–45	0.65	0.42	4.84	3.81	16.5	4.6	10.1	21	17	14
		1.1	2.4	6.5	14.3	20–25	0.74	0.48	4.84	4.84	18.7	5.2	11.5	25	20	14
		1.2	2.6	6.3	13.9	<15	0.75	0.49	4.84	5.37	19.4	5.4	11.9	27	21	14
300	661	0	0	4.7	10.4	100	0.40	0.23	5.55	0	9.5	2.6	5.7	9	9	10
607 lbs.		0.3	0.7	7.4	16.3	100	0.63	0.36	5.55	1.29	14.5	4.0	8.4	13	13	16
to		0.5	1.1	7.4	16.3	80–90	0.67	0.40	5.55	2.25	16.3	4.5	9.9	14	14	16
717 lbs.		0.7	1.5	6.6	14.6	55–65	0.67	0.40	5.55	3.37	17.1	4.7	10.4	16	15	16
		0.9	2.0	6.8	15.0	35–45	0.70	0.44	5.55	4.37	19.0	5.2	11.5	19	17	16
		1.1	2.4	7.5	16.5	20–25	0.78	0.49	5.55	5.55	21.5	6.0	13.2	23	20	16
		1.2	2.6	7.2	15.9	<15	0.79	0.50	5.55	6.16	22.3	6.2	13.7	24	20	16
350	772	0	0	5.3	11.7	100	0.46	0.26	6.24	0	10.6	2.9	6.4	10	10	12
718 lbs.		0.3	0.7	8.2	18.1	100	0.69	0.39	6.24	1.45	16.5	4.6	10.0	15	15	18
to		0.5	1.1	8.3	18.3	80–90	0.73	0.42	6.24	2.52	18.3	5.1	11.2	15	15	18
827 lbs.		0.7	1.5	7.9	17.4	55–65	0.73	0.43	6.24	3.68	19.7	5.4	11.9	15	15	18
		0.9	2.0	8.1	17.9	35–45	0.77	0.46	6.24	4.91	21.3	6.0	13.2	17	17	18
		1.1	2.4	8.3	18.3	20–25	0.81	0.50	6.24	6.23	24.0	6.6	14.5	20	19	18
		1.2[d]	2.6	8.1	17.9	<15	0.81	0.50	6.24	6.91	25.0	6.9	15.2	21	20	18
400	882	0	0	5.9	13.0	100	0.51	0.29	6.89	0	11.8	3.3	7.3	11	11	13
828 lbs.		0.3	0.7	9.1	20.0	100	0.76	0.43	6.89	1.61	18.2	5.0	11.1	16	16	13
to		0.5	1.1	8.5	18.7	70–80	0.78	0.43	6.89	2.79	19.5	5.4	11.9	15	15	19
937 lbs.		0.7	1.5	8.7	19.2	55–65	0.79	0.46	6.89	4.06	21.7	6.0	13.2	16	16	19
		0.9	2.0	8.4	18.5	20–25	0.79	0.47	6.89	5.43	23.5	6.5	14.3	17	17	19
		1.1[d]	2.4	8.3	18.3	<15	0.81	0.49	6.89	6.88	25.9	7.2	15.9	19	18	19
450	992	0	0	6.4	14.1	100	0.55	0.31	7.52	0	12.9	3.6	7.9	12	12	14
938 lbs.		0.2	0.4	8.7	19.2	100	0.74	0.41	7.52	1.14	17.4	4.8	10.6	16	16	19
to		0.5	1.1	9.3	20.5	70–80	0.80	0.46	7.52	3.05	21.3	5.9	13.0	17	17	20
1047 lbs.		0.8	1.8	9.1	20.1	35–45	0.82	0.48	7.52	5.17	24.5	6.8	15.0	16	16	20
		1.0[d]	2.2	8.5	18.7	<15	0.83	0.48	7.52	6.71	26.8	7.4	16.3	19	19	20

[a] Average weight for a feeding period.
[b] Dry matter consumption, ME and TDN allowances are based on NE requirements and the general type of diet indicated in the roughage column. Most roughages will contain 1.3–2.2 Mcal of ME/kg dry matter and 90–100% concentrate diets are expected to have 3.1 to 3.3 Mcal of ME/kg.
[c] TDN was calculated by assuming 3.6155 kcal of ME per g of TDN.
[d] Most heifers of the weight indicated, and not exhibiting compensatory growth, will fail to sustain the energy intake necessary to maintain this rate of gain for an extended period.

SOURCE: NRC, 1976.

requirements as influenced by the expected growth and maturity, or physiological state of the animal, and the nutrients required to produce selected rates of daily gain within weight ranges.

Two nutrients, digestible protein and metabolizable energy, were selected to relate nutrient content of the ration and animal growth in Stage I. These two nutrients were chosen because they explain a large portion of the nutritional influence on growth when other nutrients are present at non-limiting levels (Dent and Casey, 1967 p. 89). Environments of thermal neutrality were assumed. Genetic factors within cattle types were considered constant.

Nutrient-Gain Relationships. Linear regression equations relating; (1) digestible protein to daily gain; and (2) metabolizable energy to daily gain were determined for each weight range as provided in the requirement tables (tables 16, 17, 18, 19). These regression equations provided a continuous reference to the nutrient-gain relationship and are specific for a cattle type. Equations reflect physiological differences at varying weights and provide appropriate digestible protein and metabolizable energy requirements.

The maintenance of a nearly linear response range is aided by limits imposed on daily gain by maximum voluntary feed intake, maximum metabolizable energy intake, rate of passage, and the nutrient density of suitable feedstuffs. Because of these limiting factors the theorized non-linear, or diminishing return segment of the response curve will not be encountered. Resulting R^2's (tables 16, 17, 18, 19) indicate a linear daily gain response to nutrient additions to be a fairly good representation of data from tables 14 and 15.

TABLE 16. Linear Regression Equations Relating Daily Gain and Metabolizable Energy (ME) for Nine Weight Ranges of Traditional Steers

Relevant Weight Range (Mean Weight) Lbs.	Regression Equation	R^2
165 to 275 (220)	gain (lbs./day) = -2.50491 + .57586ME (mcals.)	.98
276 to 385 (331)	gain (lbs./day) = -2.40570 + .41305ME (mcals.)	.98
386 to 495 (441)	gain (lbs./day) = -2.31232 + .31288ME (mcals.)	.91
496 to 606 (551)	gain (lbs./day) = -2.28837 + .27231ME (mcals.)	.99
607 to 717 (661)	gain (lbs./day) = -2.22363 + .22998ME (mcals.)	.98
718 to 827 (772)	gain (lbs./day) = -2.25412 + .20941ME (mcals.)	1.00
828 to 937 (882)	gain (lbs./day) = -2.27532 + .19087ME (mcals.)	.99
938 to 1047 (992)	gain (lbs./day) = -2.23216 + .17222ME (mcals.)	.99
1048 to 1157 (1102)	gain (lbs./day) = -2.29197 + .16283ME (mcals.)	.99

TABLE 17. Linear Regression Equations Relating Daily Gain and Digestible Protein (DP) for Nine Weight Ranges of Traditional Steers

Relevant Weight Range (Mean Weight) Lbs.	Regression Equation	R^2
165 to 275 (220)	gain (lbs./day) = -0.97615 + 4.13275DP (lbs.)	.99
276 to 385 (331)	gain (lbs./day) = -1.18052 + 3.86672DP (lbs.)	.99
386 to 495 (441)	gain (lbs./day) = -1.58414 + 3.90392DP (lbs.)	.92
496 to 606 (551)	gain (lbs./day) = -1.85109 + 4.05855DP (lbs.)	.99
607 to 717 (661)	gain (lbs./day) = -2.10026 + 4.04416DP (lbs.)	.97
718 to 827 (772)	gain (lbs./day) = -2.29526 + 4.42930DP (lbs.)	.99
828 to 937 (882)	gain (lbs./day) = -2.97643 + 4.62322DP (lbs.)	.98
938 to 1047 (992)	gain (lbs./day) = -3.12619 + 4.25459DP (lbs.)	.97
1048 to 1157 (1102)	gain (lbs./day) = -3.65485 + 4.82609DP (lbs.)	.97

TABLE 18. Linear Regression Equations Relating Daily Gain and Metabolizable Energy (ME) for Eight Weight Ranges of Traditional Heifers

Relevant Weight Range (Mean Weight) Lbs.	Regression Equation	R^2
165 to 275 (220)	gain (lbs./day) = -2.11368 + .48816ME (mcals.)	.99
276 to 385 (331)	gain (lbs./day) = -2.06816 + .35428ME (mcals.)	.99
386 to 495 (441)	gain (lbs./day) = -2.17091 + .28029ME (mcals.)	.93
496 to 606 (551)	gain (lbs./day) = -2.26326 + .24980ME (mcals.)	.97
607 to 717 (661)	gain (lbs./day) = -2.22676 + .21590ME (mcals.)	.97
718 to 827 (772)	gain (lbs./day) = -2.24655 + .19195ME (mcals.)	.97
828 to 937 (882)	gain (lbs./day) = -2.27382 + .17710ME (mcals.)	.96
938 to 1047 (992)	gain (lbs./day) = -2.22898 + .16186ME (mcals.)	.98

TABLE 19. Linear Regression Equations Relating Daily Gain and Digestible Protein (DP) for Eight Weight Ranges of Traditional Heifers

Relevant Weight Range (Mean Weight) Lbs.	Regression Equation	R^2
165 to 275 (220)	gain (lbs./day) = -0.88823 + 3.80621DP (lbs.)	1.00
276 to 385 (331)	gain (lbs./day) = -1.28363 + 3.94273DP (lbs.)	.99
386 to 495 (441)	gain (lbs./day) = -1.71551 + 4.02408DP (lbs.)	.92
496 to 606 (551)	gain (lbs./day) = -2.12041 + 4.28189DP (lbs.)	.95
607 to 717 (661)	gain (lbs./day) = -2.58600 + 4.57835DP (lbs.)	.93
718 to 827 (772)	gain (lbs./day) = -2.58600 + 4.99651DP (lbs.)	.90
828 to 937 (882)	gain (lbs./day) = -3.45082 + 5.01622DP (lbs.)	.80
938 to 1047 (992)	gain (lbs./day) = -3.73415 + 5.12572DP (lbs.)	.80

By incorporating the regression equations relating pounds of daily gain and nutrient requirements for each specific weight range into a linear programming matrix particular to that weight range, the model is capable of moving along an expansion path on a least cost basis with the objective of maximizing returns. The regression equations link the feedstuff cost and nutrient analysis portion of the matrix to the product value by relating the nutrients supplied to gain. The result is the economically optimum ration producing the most desirable growth rate, i.e. the growth rate that maximizes returns.

When incorporating the regressed requirements into the linear programming matrix for each weight range, digestible protein and metabolizable energy are supplied in strict ratios, or at levels which produce like responses in gain. If either digestible protein or metabolizable energy is limiting, the gain associated with the most limiting nutrient is utilized in the analysis of feedstuffs and determines the resulting daily weight gain.

Iso-product curves developed using regressed requirements and representing the strict ratio assumption are illustrated in figure 1. The strict ratio assumption proposes that if energy or protein is limiting, the growth process will not totally cease with additions of the non-limiting nutrient but the resultant growth will be less economical than that provided when nutrients are supplied in the proper ratio.

Dry Matter Intake. As the feedstuff nutrient analysis and costs are assumed given; associated restrictions are known; desired restrictions are supplied by choice; nutrient requirements are provided on a continuous basis by regression equations; and rate of gain is a dependent

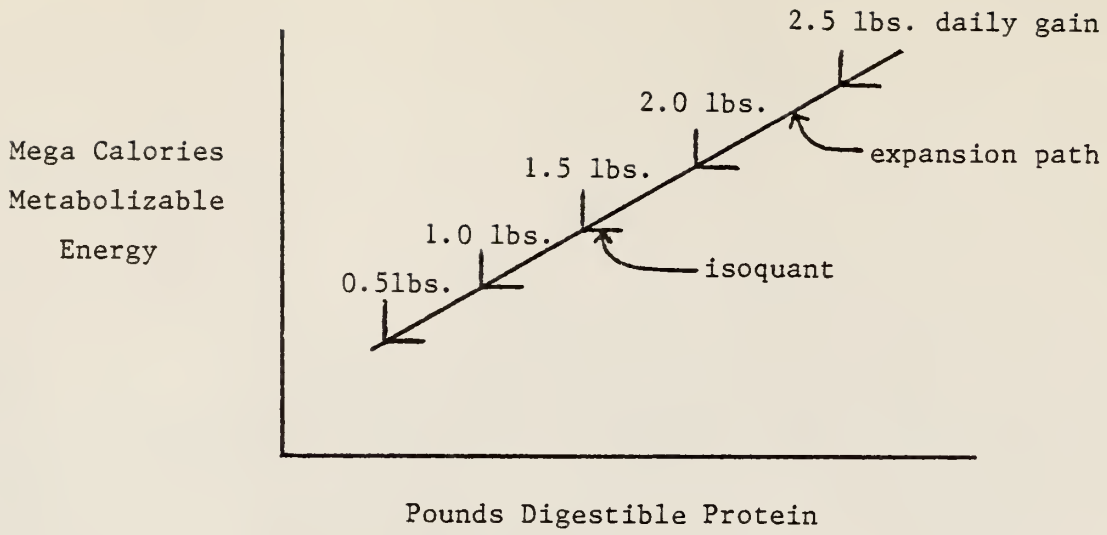

Figure 1. Protein and Energy Ratios Related to Daily Gain as Provided by Regression Equations

variable, then feed intake remains as the only unknown variable to be estimated if rations are balanced to maximize returns. Several factors are known to influence dry matter intake. Montgomery and Baumgardt (Montgomery, 1965) present a graphic example of probable relationships between energy and feed intake in ruminants relative to several controlling mechanisms (figure 2). Barring interference, animals eat to meet their caloric needs. If the ration contains a large amount of water, as-fed feed consumption will increase. If the ration contains a large amount of undigestible ingredients consumption will increase up to the point where the animal can no longer handle the bulk in the ration.

Traditional steers (600 to 700 pounds) utilized in the deferred feeding system (Chapter II) consumed an average of 18.7 pounds of dry matter per head per day. The ration fed ad libitum maintained an energy density of approximately 1.0 mega calories metabolizalbe energy per pound. The

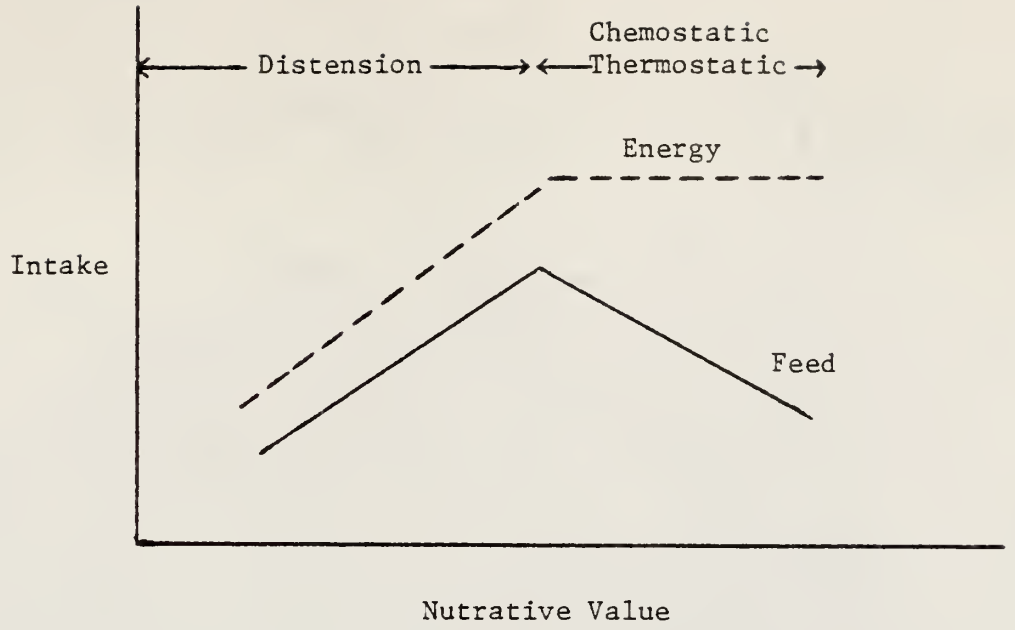

Figure 2. Probable Relationship Between Energy and Feed Intake and Several Controlling Mechanisms

metabolizable energy intake limit for steers in this weight range is 22.5 mega calories per head per day (table 14). A dry matter intake of 22.5 pounds of the field trial ration would be required to meet the upper energy intake limit. The intake of this ration, which contained 66% roughage, is assumed to be distension (stomach physical capacty) limited.

A maximum energy density ration comprised of available feedstuffs containing 66% roughage would contain 80% corn silage and 20% corn. This ration has an energy density of 1.22 mega calories metabolizable energy per pound. Energy intake limits the intake of this ration to 18.4 pounds dry matter which is approximately equal to the distension limit noted in the field experiment. Thus, rations containing approximately 60% roughage as provided by the available feedstuff set, are assumed to be equally limited by energy and distension. Any increase in dry matter

intake is met by the distension limit. Any reduction in the roughage level while dry matter intake is maintained (increase in the energy level) is met by the energy limit. Thus, intake for a steer in this weight range is limited to a maximum of 18.1 pounds dry matter and/or 22.5 mega calories metabolizable energy. With energy and distension being equally limiting at the 60% roughage level, this relationship was assumed to apply to all weight ranges for traditional steers and heifers. Utilizing this assumption, plus the maximum energy density ration and the maximum metabolizable energy intake limits from tables 14 and 15, estimates of energy limited levels of dry matter intake were made (table 20). From these estimates, distension limited levels of dry matter intake were assumed to equal the energy limited levels at 60% roughage content.

Ration Types and Nutritional Restrictions. Three necessary ration types were considered in formulating Stage I, (1) backgrounding, (2) transition, and (3) finishing.

Gain is limited during the backgrounding phase to aid in coordiating backgrounding and finishing phases. Backgrounding is designed to provide a feeder animal of desirable weight and finish for placement in the finishing phase. A gain limit consistent with tables 14 and 15 can be included to insure that data limits are not exceeded and to allow for the formulation of rations that provide the selected non-optimal rates of gain required for developing backgrounding rations.

Rumminant animals need time to adapt to changing feedstuffs. Since microorganisms develop into populations which reflect the composition of the feed, ruminant animals should not be suddenly changed from one ration to a vastly different one, especially when changing from a high

TABLE 20. Estimated Dry Matter Intake as Limited by Energy Consumption

Mean Weight of Weight Range (lbs.)	Roughage Level 83%[b]	60%[a]	30%[c]	15%[d]
Steers	---------- Pounds Dry Matter ----------			
S551	16.2	15.0	13.6	13.0
S661	19.6	18.1	16.4	13.7
S772	22.0	20.4	18.5	17.7
S882	24.3	22.6	20.4	19.6
S992	26.5	24.6	22.3	21.3
S1102	27.3	25.3	22.9	22.0
Heifers				
H551	16.9	15.6	14.2	13.6
H661	19.4	18.0	16.3	15.6
H772	21.7	20.0	18.2	17.5
H882	22.5	20.9	18.9	18.1
H992	23.3	21.6	19.6	18.7

[a]Distension and energy are assumed to equally limit dry matter intake.

[b]Distension would prevent dry matter intake from reaching the energy limited intake level.

[c,d]Energy intake would prevent dry matter intake from reaching the distension limited intake level.

roughage ration to one high in readily available carbohydrates (Church, 1976). Transition rations provide the gradual shift in ration ingredients required.

Drylot performance is generally improved, and nutritional disorders minimized when small amounts of roughage are included in finishing rations (Preston, 1974). Some individual feedstuffs may characteristically require maximum limits be imposed to prevent nutritional disorders.

Upper and/or lower limit restrictions on total concentrates and total roughages were incorporated as a percentage of total dry matter. Upper and/or lower restriction limits on individual feedstuffs may be included: (1) as a percentage of total concentrate; or (2) as a percentage of total roughage; or (3) as a percentage of total dry matter intake. These nutrient restrictions can be utilized in formulating the various ration types and in incorporating nutritional limitations.

Cost Factors. In addition to daily feedstuff costs, daily yardage and interest costs were included in determining daily production cost. Thus returns are equal to daily production value less daily feedstuff, yardage and interest costs. Yardage is a daily per head charge and is unaffected by other coefficients in the model. Interest cost is a function of acquisition cost (purchase, trucking, processing and veterinary costs), daily feedstuff cost, and daily yardage cost. [Daily interest cost = (total acquisition cost + total daily feedstuff cost + daily yardage cost) * annual interest rate/365]

Linear Programming Matrix. Returns are maximized on a daily basis. Mathematically stated, Stage I for each weight class may be summarized

as follows:

$$\text{Maximize} \quad GY - \sum_{T=1}^{N} P_T X_T - H\left(\sum_{T=1}^{N} P_T X_T + M + I\right) - I$$

$$\text{Subject to:} \quad J \geq \sum_{T=1}^{N} X_T$$

$$K \geq \sum_{T=1}^{N} R_T X_T$$

$$O \leq \sum_{T=1}^{N} S_T X_T$$

$$Y_e = \left(\sum_{T=1}^{N} R_T X_T\right)(A) + B$$

$$Y_p = \left(\sum_{T=1}^{N} S_T X_T\right)(C) + D$$

$$Y \leq Y_e$$

$$Y \leq Y_p$$

$$Y \leq L$$

$$X_T \leq J_T$$

$$X_T \geq U_T$$

G = market value of the live animal ($/lb.)

Y = daily gain (lb.)

T = individual feedstuff

P_T = cost of feedstuff T ($/lb. DM)

X_T = quantity of feedstuff T (lb. DM)

H = daily interest rate (%)

M = acquistion cost ($/head)

I = daily per head yardage cost ($)

K = maximum daily metabolizable energy intake (Mcal)

R_T = metabolizable energy concentration in feedstuff T (Mcal/lb. dry matter)

J = maximum daily dry matter intake (lb.)

S_T = digestible protein concentration in feedstuff T (lb./lb. dry matter)

Y_e = daily gain supported by metabolizable energy concentration of the ration (lb.)

A = coefficient of additional gain related to additional units of metabolizable energy (R)

B = intercept coefficient of gain related to metabolizable energy (R)

Y_p = daily gain supported by digestable protein concentration of the ration (lb.)

C = coefficient of additional gain related to additional units of digestible protein (S)

D = intercept coefficient of gain related to digestible protein (S)

L = maximum daily gain limit (lb.)

N = number of feedstuffs

J_T = maximum dry matter consumption of feedstuff T per day (lb.)

U_T = minimum dry matter consumption of feedstuff T per day (lb.)

An example matrix of Stage I as noted in linear programming terms is given in Appendix A, figure 3.

Application of Stage I - Traditional Steer and Heifer

Stage I was utilized to determine optimum feeding systems for two specific cattle types - traditional steers and traditional heifers. It was assumed that both steers and heifers were purchased at 506 pounds and placed on feed at 496 pounds (2% shrink). Steers were fed to a selected finishing weight of 1157 pounds; heifers to a slected finishing weight of 1047 pounds (both steer and heifer finishing weights are the upper data limit, tables 14 and 15).

Restrictions. The feedstuff set included corn, grain sorghum, wheat, soybean meal, alfalfa, corn silage, and prairie hay. All feedstuffs, the nutrient analysis of feedstuffs (NRC, 1976), and measures of intake were represented on a 100% dry matter basis. An upper limit was placed on wheat for all rations at 30% of concentrate consumption (Preston, 1974). Corn, grain sorghum, wheat, and soybean meal were designated at 100% concentrate. Corn silage, commonly containing 5 to 7 bushels of corn grain per ton, was designated at 17% concentrate and 83% roughage (6 bushel per ton * 56 pounds per bushel = 336 pounds per ton / 2000 pounds per ton = .168 or 17%). Alfalfa and prairie hay were designated as 100% roughage. A lower limit on roughage was set at 15% for all rations (Church, 1978).

Rations for potential backgrounding periods or weight ranges were limited to permitting 2.25 pounds gain per head per day for steers. This represented approximately 75% (2.25/3 = .75) of the gain potential for 496 to 717 pound steers (table 14). The same limit imposed on potential heifer gains within the potential backgrounding weight range resulted in a 1.95 (2.6 * .75 = 1.95) pound per head per day gain limit

(table 15).

Rations formulated for the transition phase provided a gradual shift in ration ingredients and was comprised of two rations, each fed for two weeks (Church, 1976). The first transition ration following the backgrounding phase was restricted to a minimum of 60% roughage, the second to a minimum of 30% roughage.

Finishing ration formulations evaluated all available feedstuffs as restricted by total dry matter intake and/or maximum metabolizable energy intake, upper gain limit, upper wheat limit as a percent of concentrate consumption, and a minimum roughage limit placed at 15% of total dry matter intake.

Selected Inputs. Feedstuff costs were established using historic ratios as developed in Chapter II, and are given in table 21.

TABLE 21. Feedstuff Costs Utilized in the Application of the Simulation Model, Stage I

Feedstuff	$/lb. dry matter
Corn	.05866
Grain sorghum	.05285
Wheat	.06582
Soybean meal	.12635
Alfalfa	.03563
Corn silage	.04223
Prairie hay	.03153

Price quotes representing marketable products for each weight range were also entered into Stage I (table 22).

Interest rate was set at 9.5% and yardage cost was $.06 per head per day. Acquisition cost was calculated as purchase cost + processing and veterinary costs + trucking cost and equalled $436.60 for heifers (506 lb. purchase weight * $.85 purchase price + $4.50 processing and veterinary costs + $2.00 trucking cost = $436.60) and 502.38 for steers (506 * $.98 + $4.50 + $2.00 = 502.38).

Rations were labeled indicating sex of the traditional cattle type, mean weight for the effective weight range, ration type, and the number of like ration types within weight ranges as illustrated in table 23.

TABLE 22. Model Stage I Estimated Price Quotes for Marketable Products

Mean Weight of Weight Range	Steer $/lb.	Heifer $/lb.
Purchase Weight 506 pounds		
551	.98	.85
661	.90	.78
772	.84	.73
882	.79	.69
992	.68	.67
1102	.68	

SOURCE: Kansas City; March 6, 1979.

TABLE 23. Simulation Model - Stage I Labeling of Rations

	a	b	c	d
RATION	S	661	T	2

a) Sex of traditional cattle type

S - steer

H - heifer

b) Mean weight of the weight range for which the ration has been formulated, indicating the nutrient requirements utilized.

c) Ration type

B - backgrounding or growing

T - transition or step-up

F - finishing

d) Records progression of a like ration type within a weight range.

Example - three transition or step-up rations are deemed necessary.

S661T1

S661T2

S661T3

Ration Formulations. Once a matrix was established as required for formulating the initial ration, modifications were incorporated to formulate different ration types and adjust nutrient requirements for each different weight range. A set of potential rations was formulated for traditional steers and traditional heifers (tables 24 and 25).

Not all rations formulated were utilized in the final feeding system. The non-utilized rations were formulated since it was not initially clear what type of ration would be required within each weight range.

Results

A 125 day finishing phase was selected which reflects the animals ability to sustain production during the finishing phase, subject to the rations formulated. Figuring backwards form the selected off feed weight (1157 pounds for steers, 1047 pounds for heifers) and using the daily gain associated with rations formulated and weight ranges, the weight at which the animal must be placed on the finishing ration was determined (784 pounds for steers, 763 pounds for heifers).

The animal must be grown form the on-feed weight (496 lbs. for the steer and heifer) to the weight at which it will be placed on the finishing ration. Backgrounding and transition phases were required. The weight gain associated with the four week transition phase was subtracted to determine the upper weight limit of the backgrounding phase or the beginning of the transition phase. The remaining production, purchase weight to the beginning of the transition phase, was provided by the backgrounding phase. In this manner, appropriate rations were selected from the set of rations formulated to construct the best coordinated

TABLE 24. Simulated Traditional Steer Ration Set; Daily Estimates (Dry Matter Basis)

Ration	$ Gross Income	$ Feed Costs	$ Interest and Yardage	$ Returns	$ Feed Cost per lb.	Lbs. Dry Matter Consumption	Percent Corn	Percent Soybean Meal	Percent Alfalfa	Percent Corn Silage	Percent Prairie Hay	Percent Roughage	Pounds DP	Percent DP	Mcals. ME	Mcals. ME per lb.	Gain Pounds
S551B	2.03	.63	.19	1.21	.0420	15.0	7.06		24.85	68.09		81.36	1.01	6.73	16.67	1.11	2.25
S661B	1.89	.73	.19	.97	.0403	18.1			17.57	72.89	9.54	87.61	1.08	5.97	19.45	1.07	2.25
S661T1	2.47	.89	.19	1.39	.0492	18.1	23.82	3.89		72.29		60.00	1.25	6.91	22.47	1.24	2.94
S661T2	2.48	.86	.19	1.43	.0475	18.1	38.49		15.18	43.34		53.64	1.25	6.91	22.50	1.24	2.95
S772T1	2.40	.98	.19	1.23	.0480	20.4	26.09	1.86	1.15	70.91		60.00	1.27	6.23	25.30	1.24	3.04
S772T2	2.40	.96	.19	1.25	.0471	20.4	32.83		8.40	58.26		57.18	1.27	6.23	25.30	1.24	3.04
S772F	2.40	.96	.19	1.25	.0471	20.4	32.83		8.40	58.26		57.18	1.27	6.23	25.30	1.24	3.04
S882F	2.27	1.06	.19	1.02	.0469	22.6	29.10		3.66	67.25		59.47	1.31	5.80	28.00	1.24	3.07
S992F	2.05	1.15	.19	.71	.0467	24.6	27.31		.78	71.91		60.46	1.36	5.53	30.50	1.24	3.02
S1102F	1.92	1.18	.19	.55	.0466	25.3	27.13			72.87		60.48	1.34	5.30	31.40	1.24	2.82

TABLE 25. Simulated Traditional Heifer Ration Set; Daily Estimates (Dry Matter Basis)

Ration	$ Gross Income	$ Feed Costs	$ Interest and Yardage	$ Returns	$ Feed Cost per lb.	Lbs. Dry Matter Consumption	Percent Corn	Percent Soybean Meal	Percent Alfalfa	Percent Corn Silage	Percent Prairie Hay	Percent Roughage	Pounds DP	Percent DP	Mcals. ME	Mcals. ME per lb.	Gain Pounds
H551B	1.52	.63	.17	.72	.0404	15.6			19.33	74.58	6.10	87.32	.95	6.09	16.87	1.08	1.95
H661B	1.42	.72	.17	.53	.0400	18.0			11.99	74.12	13.89	87.40	.99	5.50	19.35	1.08	1.95
H661T1	1.89	.86	.17	.86	.0478	18.0	26.31	1.79	1.91	69.98		60.00	1.13	6.28	22.30	1.24	2.59
H661T2	1.89	.85	.17	.87	.0472	18.0	32.81		8.91	58.28		57.28	1.13	6.28	22.30	1.24	2.59
H661F	1.89	.85	.17	.87	.0472	18.0	32.81		8.91	58.28		57.28	1.13	6.28	22.30	1.24	2.59
H772T1	1.76	.94	.17	.65	.0465	20.2	26.12			73.88		61.32	1.10	5.44	25.00	1.24	2.55
H772T2	1.76	.94	.17	.65	.0465	20.2	26.12			73.88		61.32	1.10	5.44	25.00	1.24	2.55
H772F	1.76	.94	.17	.65	.0465	20.2	26.12			73.88		61.32	1.10	5.44	25.00	1.24	2.55
H882F	1.55	.97	.17	.41	.0464	20.9	26.99			72.44		60.70	1.15	5.50	25.90	1.24	2.31
H992F	1.39	1.01	.17	.21	.0468	21.6	27.02			72.98		60.57	1.14	5.28	26.80	1.24	2.11

feeding systems (table 26).

For steers, returns ranged from $1.25 to $.55 per head per day. Returns for heifers ranged from $.87 to $.21 per head per day.

The roughage content of formulated rations seldom dropped below 60% as corn silage (83% roughage) was the least cost supplier of metabolizable energy ($.0422 per lb. dry matter / 1.15 mega calories ME per lb. dry matter = $.0367 per mega calories ME). Thus, ME is supplied by corn silage and corn grain (second lowest cost supplier of ME). Consequently, both ME and total dry matter (distension) upper limits are met for all finishing rations.

Model - Stage II

Stage II of the simulation model is a cost and production analysis model designed to evaluate the cattle-type specific optimum rate of gain rations, and selected feeding systems developed in Stage I.

Formulation

Stage II provides a production analysis including days on feed, total gain, average daily gain, total dry matter feed intake, dry matter feed intake per day, dry matter feed per pound of gain, and an as fed feed summary indicating total as fed feed intake for all feedstuffs. The cost analysis indicates total investment cost, total production cost, total feed cost, total yardage cost, total interest cost, cost of feed per pound of gain, cost of yardage per pound of gain, cost of interest per pound gain, and total cost per pound of gain.

Analysis is available for selected intervals within the total

TABLE 26. Outline for Coordinating Backgrounding and Finishing Phases Utilizing the Ration Sets Developed in Stage I

Desired length of finishing phase	125 days
Weight on feed (steers and heifers)	496 pounds
Desired ending weight (analysis is desired to the upper weight limit of the available data)	
Steer	1157 pounds
Heifer	1047 pounds

Desired transition phase - two rations, each fed for two weeks

	Ration	Beginning Weight	Ending Weight	Average Daily Gain	Estimated Days	Cumulative Total Days
STEER:	S1102F	1047	1157	2.82	39	39
	S992F	937	1047	3.02	36	75
	S882F	827	937	3.07	36	111
	S772F	784[a]	827	3.04	14	125
	S772T2	741	784	3.04	14	138
	S772T1	698	741	3.04	14	152
	S661B	606	698[b]	2.25	41	194
	S551B	496	606	2.25	49	243
HEIFER:	H992F	937	1047	2.11	52	52
	H882F	827	937	2.31	48	100
	H772F	763[c]	827	2.55	25	125
	H772T2	727	763	2.55	14	139
	H661T1	691	727	2.59	14	153
	H661B	606	691[d]	1.95	44	197
	H551B	496	606	1.95	56	253

[a]The steer can finish from 784 lbs. in 125 days

[b]The steer must be backgrounded to 698 lbs.

[c]The heifer can finish from 763 lbs. in 125 days

[d]The heifer must be backgrounded to 691 lbs.

production process. These selected intervals are denoted as "period" analysis, while the analysis of the total production process is labeled "to date" analysis. The "period" analysis and "to date" analysis can be provided at selected weights or following a selected period of days (tables 27 and 28).

Production and cost inputs incorporated into Stage II include feeding periods for selected rations as limited by days or attained weight, regression equations relating nutrient gain responses specific to weight ranges, calculated futures minus cash price and/or heifer basis, trucking costs, processing and veterinary costs, interest rate, beginning and ending weight, and purchase price.

The cost analysis model evaluates the digestible protein / metabolizable energy ratio supplied by each selected ration by utilizing the regression equations developed for the linear programming ration formulation model. This results in production responses that are identical to those provided by the ration formulation model. The regression equations, however, allow Stage II of the simulation model to evaluate any ration based on the strict protein / energy ratio assumption, i.e. no growth response beyond the bound of the most limiting nutrient evaluated (protein or energy). Even though Stage II can be used independently, maximum accuracy and optimum results are provided when used in conjunction with Stage I. Stage II variable name descriptions, flowchart relating print and ration selection, and an eight ration example program are included in Appendix B.

Application

Stage II was utilized to evaluate the results of Stage I construction

TABLE 27. Simulation Model - Stage II Production Analysis Equations

"to date"

Days to date = days to date

Weight to date (lbs.) = weight on feed + gain

Gain to date (lbs.) = gain to date + gain

Average daily gain to date (lbs.) = weight to date/days to date

Feed consumed to date (lbs. dry matter) = lbs. ration 1 + ···· lbs. ration 8

Feed consumed per day to date (lbs. dry matter) = feed consumed to date/ days to date

Feed per lb. gain to date (lbs. dry matter) = feed consumed to date/gain to date

Feed summary to date (lbs. as fed) = ration 1 * % feedstuff + ···· ration 8 * % feedstuff, for all feedstuffs

"period"

Additional days = days to date - days end of previous period

Ending weight period (lbs.) = weight to date

Gain period (lbs.) = gain to date - gain end of previous period

Average daily gain period (lbs.) = gain period/additional days

Feed consumed period (lbs. dry matter) = feed to date - feed end of previous period

Feed consumed per day period (lbs. dry matter) = feed consumed period/ additional days

Feed per lb. gain period (lbs. dry matter) = feed consumed period/gain period

Feed summary period (lbs. as fed) = feedstuff to date - feedstuff end of previous period

TABLE 28. Simulation Model - Stage II Cost Analysis Equations

"to date"

Feed cost to date ($) = ration 1 * $/lb. ration 1 + ···· ration 8 * $/lb. ration 8

Yardage to date ($) = day to date * daily yardage rate ($)

Interest ot date ($) = to date interest + period interest

Total production cost to date ($) = feed cost to date + yardage to date + interest ot date + veterinary costs + trucking costs

Total investment to date ($) = total production costs + purchase cost

Cost of feed per lb. gain to date ($) = feed cost to date/gain to date

Cost of yardage per lb. gain to date ($) = yardage to date/gain to date

Cost of interest per lb. gain to date ($) = interest to date/gain to date

Total cost per lb. gain to date ($) = total production cost to date/gain to date

"period"

Feed cost period ($) = feed cost to date - feed cost end of previous period

Yardage period ($) = yardage to date - yardage end of previous period

Interest period ($) = ((purchase cost + feed cost end of provious period + yardage end of previous period) * (additional days/365)) * interest rate

Total production costs period ($) = feed cost period + yardage period + interest period

Total investment period ($) = total production cost period

Cost of feed per lb. gain period ($) = feed cost period/gain period

Cost of yardage per lb. gain period ($) = yardage period/gain period

Cost of interest per lb. gain period ($) = interest period/gain period

Total cost per lb. gain period ($) = total production cost period/gain period

of feeding systems for traditional steers and traditional heifers. Inputs derived from the rations formulated in Stage I were pounds dry matter intake per day, mega calories metabolizable energy per pound dry matter, pounds digestable protein per pound dry matter, ration cost per pound dry matter and individual feedstuffs as a percentage of ration composition. Upper limits bounding the use of individual rations from Stage I for each cattle type were incorporated as an upper weight limit for a given ration or as an upper time limit in days.

Purchase weight, calculated futures minus cash and/or sex basis, trucking costs, processing and veterinary costs, purchase price, interest rate, yardage costs, and feed mark-up were as in Stage I (table 29).

Results

Break-even price for heifers was $.6961 per pound (4% pencil shrink, 1005 pounds) as compared to $.7036 per pound (4% pencil shrink, 1111 pounds) for steers. While the heifer and steer feeding systems are assumed optimal for the selected weight range (496 to 1047 for heifers and 496 to 1157 for steers) these selected weight ranges do not represent specific optimum placement and off-feed weights for heifers or steers. However, the break-even price differential (heifer - steer) of $-.0075 is consistent with recorded heifer minus steer market price differentials (Omaha, Sioux City, Kansas City, 1977 average differential = $-.0154). These results demonstrate the correctness of the heifer ($85.00/cwt.) and steer ($98.00/cwt., K.C. average March 3, 1979) feeder price differential utilized in the analysis. Complete Stage II cost and production analysis, for Stage I constructed feeding systems, is presented for a

TABLE 29. Summary of Input Values Used in the Cost Analysis Model - Stage II, Traditional Steers and Traditional Heifers

Steer futures minus cash price basis[a]	$ 2.00/cwt.[b]
Heifer sex basis[c]	$ 1.75/cwt.
Trucking to feedlot	$ 2.00/head
Processing and veterinary	$ 4.50/head
Steer and heifer purchase weight	506.0 pounds
Steer purchase price	$ 98.00/cwt.
Heifer purchase price	$ 85.00/cwt.
Steer and heifer weight on feed (purchase weight * .98)	496.0 pounds
Annual interest rate (assumes a line of credit and no compounding)	9.50 percent
Yardage	$ .06/hd/day
Feed mark-up	$ 10.50/ton
Brokerage fee (40,000 lb. live cattle contract)	$ 40.00
Average margin maintained	$ 2500.00

[a]Steer futures minus cash price basis = calculated difference between present cash price and present futures price for a selected futures option or contract month traded.

[b]Kimple, 1978

[c]Heifer sex basis = calculated difference between present cash finished steer and present cash finished heifer price.

steer and a heifer in Appendix C.

While steers gained 662 pounds as compared to the 553 pounds gained by heifers, they required 11 less days to do so. As a result yardage cost per pound of gain was $.0221 for steers, and $.0276 for heifers. The additional 109 pounds produced by the steers indicates a greater profit potential and guaranties greater gross returns. Acquisition costs and feed costs were lower for heifers. Yet, because of the lower rate of gain, interest cost per pound of gain was greater for heifers ($.0608 for a heifer, $.0561 for a steer).

Feed cost per pound of gain was greater for the heifer, $.3897, as compared to $.3445 for the steer. This difference can be attributed to the steer being later-maturing and the equivalent placement weight. Identical on-feed weight for animals which are known to mature differently would indicate a difference in efficiency at time of placement, with steers accumulating more pounds from equally or more efficient production periods.

The evaluation of hedging prospects includes a $.0175 per pound heifer basis and a $.02 per pound futures price minus cash price basis. The hedge price required to provide a $20.00 margin [margin = (weight to date lbs. * (1 - .04) * appropriate futures quote $/lb.) - (total investment to date $) - ((weight to date lbs. * (1 - .04)) * (basis/lb. + commission /lb. + (average margin/lb. * (days to date/365) * annual interest rate)))] was $.7585 per pound for a heifer, $.7465 for a steer.

CHAPTER IV

EVALUATING FEEDING SYSTEMS for GROUND BEEF PRODUCTION - "HAMBURGER STEER" (TRADITIONAL CATTLE TYPES)

Introduction

With the rebuilding phase of the cattle cycle, cow slaughter and non-fed slaughter have declined. During the last ten years these two slaughter classes have been the source of 46% of ground and processed beef. The reduction in the ground beef source, coupled with an increased demand for the product, has prompted inquiries as to the feasibility of a steer being fed, and specifically designated, for ground beef production (a "hamburger" steer). Fast food franchises marketing large quantities of ground beef have attempted to arouse interest in the "hamburger" steer in an effort to boost dwindling supplies of ground beef and forestall the utilization of a higher quality, more expensive substitute source. Such franchises suggest that the production of the "hamburger" steer would be financially beneficial for both the producer and themselves.

It has been suggested that a feeding system incorporating a shortened finishing phase would provide the desired product. The simulation model, Stage I and Stage II, was used to evaluate production and cost data for traditional steers managed under six selected feeding system. Feeding systems were designed to evaluate the influence of a shortened finishing phase. Stage I of the model was used in formulat-

ing a ration set, with each ration maximizing returns (income - variable costs) for the associated weight range (table 30). Six feeding systems were constructed from the ration set. Stage II provided a production and cost analysis for the six feeding system, traditional steer combination. The objective of the analysis was to determine the feasibility of utilizing traditional steers in shortened finishing phase, "hamburger" steer, feeding systems.

Feeding Systems

Feedstuff costs, developed using historic price ratios (Kansas 1970-77, prices recieved by farmers) plus transportation and handling costs, were utilized in formulating the ration set from which feeding systems were constructed. Input costs, unless specifically noted, were the same as given in Chapter III, i.e. future price - cash price basis, $.02/pound; trucking cost, $2/head; processing and veterinary costs, $4.50/head; annual interest rate, 9.5%; and shrink, 4% of off-feed weight.

Feeding systems 1, 2, 3 and 4 utilized a steer placed on feed at 496 pounds (2% shrink from purchase weight) and purchased at $.98 per pound. Feeding System 1 is identical to the system developed in Chapter III. Feeding System 1 combined a 90 day backgrounding phase, 28 day transition phase and 125 day finishing phase to provide the desired finishing weight of 1157 pounds (table 31). Feeding System 2 incorporated a shortened finishing phase while the weight at which the steer was placed on the finishing ration (787 pounds) was the same as

TABLE 30. Model Ration Set for Evaluation of Traditional "Hamburger" Steer

Ration	$ Gross Income	$ Feed Costs	$ Interest and Yardage	$ Returns	$ Feed Cost per lb.	Lbs. Dry Matter Consumption	Percent Corn	Percent Soybean Meal	Percent Alfalfa	Percent Corn Silage	Percent Prairie Hay	Percent Roughage	Pounds DP	Percent DP	Mcals. ME	Mcals. ME per lb.	Gain Pounds
S551B	2.03	.63	.19	1.21	.0420	15.0	7.06		24.85	68.09		81.36	1.01	6.73	16.67	1.11	2.25
S551T1	2.50	.76	.19	1.55	.0507	15.0	21.91	5.83	.12	72.14		60.00	1.14	7.60	18.60	1.24	2.78
S551T2	2.50	.72	.19	1.59	.0480	15.0	43.08		22.91	34.01		51.14	1.14	7.60	18.60	1.24	2.78
S551F	2.50	.72	.19	1.59	.0480	15.0	43.08		22.91	34.01		51.14	1.14	7.60	18.60	1.24	2.78
S611B	1.89	.73	.19	.97	.0403	18.1			17.57	72.89	9.54	87.61	1.08	5.97	19.45	1.07	2.25
S661T1	2.47	.89	.19	1.39	.0492	18.1	23.82	3.89		72.29		60.00	1.25	6.91	22.47	1.24	2.94
S661T2	2.48	.86	.19	1.43	.0475	18.1	38.49		15.18	43.34		53.64	1.25	6.91	22.50	1.24	2.95
S661F	2.48	.86	.19	1.43	.0475	18.1	38.49		15.18	43.34		53.64	1.25	6.91	22.50	1.24	2.95
S772B	1.78	.80	.19	.79	.0392	20.4			10.69	67.88	21.43	88.46	1.09	5.34	22.50	1.05	2.25
S772T1	2.40	.98	.19	1.23	.0480	20.4	26.09	1.86	1.15	70.91		60.00	1.27	6.23	25.30	1.24	3.04
S772T2	2.40	.96	.19	1.25	.0471	20.4	32.83		8.40	58.26		57.18	1.27	6.23	25.30	1.24	3.04
S772F	2.40	.96	.19	1.25	.0471	20.4	32.83		8.40	58.26		57.18	1.27	6.23	25.30	1.24	3.04
S882F	2.27	1.06	.19	1.02	.0469	22.6	29.10		3.66	67.25		59.47	1.31	5.80	28.00	1.24	3.07
S992F	2.05	1.15	.19	.71	.0467	24.6	27.31		.78	71.91		60.46	1.36	5.50	30.50	1.24	3.02
S1102F	1.92	1.18	.19	.55	.0466	25.3	27.13			72.87		60.48	1.34	5.30	31.40	1.24	2.82

TABLE 31. Simulated Feeding System Number 1 - Basis System, Upper Weight Limit of Data Set

Conditions:

1) Weight on feed = 496 lbs.

2) Desired finishing weight = 1157 lbs.

3) 125 day finishing phase

Ration	Beginning Weight	Ending Weight	Average Daily Gain	Estimated Days	Cumulative Total Days Finishing Ration	Cumulative Total Days
S1102F	1047	1157	2.82	39	39	39
S992F	937	1047	3.02	36	75	75
S882F	827	937	3.07	36	111	111
S772F	784	827	3.04	14	125	125
S772T2	741	784	3.04	14		138
S772T1	698	741	3.04	14		152
S661B	606	698	2.25	41		194
S551B	496	606	2.25	49		243

selected for feeding System 1. Estimated finishing weight for System 2 was 1015 pounds (table 32). Feeding System 3 restored the 125 day finishing weight estimated for System 2 (1015 pounds). Estimated weight for placement in the finishing phase in System 3 was 637 pounds (table 33). Following a 28 day transition phase System 4 utilized a 125 day finishing phase. Target weight for placement in the finishing phase was 574 pounds and the estimated finishing weight was 947 pounds (table 34).

Feeding Systems 5 and 6 utilized heavier feeder steers (700 pounds, 2% shrink from purchase weight) assumed to have been purchased at $.84 per pound. System 5 combined a 28 day transition phase and 125 day finishing phase to produce the desired finishing weight of 1157 pounds (table 35). System 6 incorporated a shortened finishing phase (75 days) and a 28 day transition phase, with the weight at which the steer was placed in the finishing phase being the same as for System 5 - 784 pounds (table 36).

Results

Feeding System 1 (496 lbs. to 1157 lbs., 125 day finishing phase) provided the lowest break even price ($.7036) and the greatest total gain (662 lbs.) compared to all other feeding systems (table 37). It can be assumed, based on finishing weight and time on feed, that no other feeding system resulted in a higher quality end product when compared to System 1. Thus, these three production and cost factors (break even price, total pounds produced and quality grade) all affect-

TABLE 32. Simulated Feeding System Number 2 - Shortened Finishing Phase

Conditions:

1) Weight on feed = 496 lbs.

2) Target weight for placement on the finishing ration = 787 lbs. (same placement weight as resulted in feeding system number 1).

3) 75 day finishing phase

Ration	Beginning Weight	Ending Weight	Average Daily Gain	Estimated Days	Cumulative Total days Finishing Ration	Cumulative Total Days
S992F	937	1015	3.02	26	75	194
S882F	827	937	3.07	36	49	168
S772F	787	827	3.04	13	13	132
S772T2	744	787	3.04	14		119
S772T1	701	744	3.04	14		105
S661B	606	701	2.25	42		91
S551B	496	606	2.25	49		49

TABLE 33. Simulated Feeding System Number 3 - Decreased Finishing Weight

Conditions:

1) Weight on feed = 496 lbs.

2) Target finishing weight in 1015 lbs. (same finishing weight as resulted in feeding system number 2).

3) 125 day finishing phase

Ration	Beginning Weight	Ending Weight	Average Daily Gain	Estimated Days	Cumulative Total Days Finishing Ration	Cumulative Total Days
S992F	937	1015	3.02	26	26	26
S882F	827	937	3.07	36	62	62
S772F	717	827	3.04	36	98	98
S661F	637	717	2.95	27	125	125
S661T2	596	637	2.95	14		139
S551T1	557	596	2.78	14		153
S551B	496	557	2.25	27		180

TABLE 34. Simulated Feeding System Number 4 - No Backgrounding Phase

Conditions:

1) Weight on feed = 496 lbs.

2) No backgrounding, but transition rations required.

3) 125 day finishing phase

Ration	Beginning Weight	Ending Weight	Average Daily Gain	Estimated Days	Cumulative Total Days Finishing Ration	Cumulative Total Days
S882F	827	947	3.07	39	125	153
S772F	717	827	3.04	36	86	114
S661F	606	717	2.95	38	50	78
S551F	574	606	2.78	12	12	40
S551T2	535	574	2.78	14		28
S551T1	496	535	2.78	14		14

TABLE 35. Simulated Feeding System Number 5 - Increased Purchase Weight

Conditions:

1) Weight on feed = 700 lbs.

2) Desired finishing weight = 1157 lbs.

3) 125 day finishing phase; transition rations are required.

Ration	Beginning Weight	Ending Weight	Average Daily Gain	Estimated Days	Cumulative Total Days Finishing Ration	Cumulative Total Days
S1102F	1047	1157	2.82	39	39	39
S992F	937	1047	3.02	36	75	75
S882F	827	937	3.07	36	111	111
S772F	784	827	3.04	14	125	125
S772T2	742	784	3.04	14		139
S772T2	700	742	3.04	14		153

TABLE 36. Simulated Feeding System Number 6 - Increased Purchase Weight and Shortened Finishing Phase

Conditions:

1) Weight on feed = 700 lbs.

2) Target weight for placement on finishing ration = 784 lbs. (same placement weight as resulted in feeding system number 5).

3) 75 day finishing phase

Ration	Beginning Weight	Ending Weight	Average Daily Gain	Estimated Days	Cumulative Total Days Finishing Ration	Cumulative Total Days
S992F	937	1013	3.02	25	75	103
S882F	827	937	3.07	36	50	78
S772F	784	827	3.04	14	14	42
S772T2	742	784	3.04	14		28
S772T1	700	742	3.04	14		14

TABLE. 37. Summary of Production and Cost Data for Six Simulated Feeding Systems (Traditional Steer)

Feeding System	Days Backgrounding	Days Transition	Days Finish	Total days	On feed Weight Pounds	Off feed Weight Pounds	Total Gain Pounds	Average Daily Gain Pounds	Total $ Cost of Gain To Date	$ Cost of Gain Last Period	$ Total Interest	$ Total Yardage	$ Feed Cost	Total $ Production Cost	Total $ Investment Cost	$ Break Even
1	90	28	125	243	496	1158	662	2.71	.4326	.5046	37.18	14.64	228.16	286.48	782.28	.7036
2	91	28	75	194	496	1017	521	2.67	.4165	.4563	28.47	11.70	170.16	216.82	712.63	.7302
3	27	28	125	180	496	1017	521	2.88	.4025	.4559	26.46	10.86	166.02	209.84	705.64	.7225
4	0	28	125	153	496	948	452	2.96	.3877	.4150	21.84	9.18	137.87	175.39	671.19	.7372
5	0	28	125	153	700	1160	460	2.99	.4398	.4919	19.70	9.24	167.27	202.21	801.97	.7203
6	0	28	74	103	700	1014	314	3.05	.4210	.4444	12.50	6.18	107.41	132.09	731.84	.7520

ing potential profitability, were superior for feeding System 1, when all feeding systems were considered.

Any reduction in the length of the finishing phase, System 2 compared to System 1 and System 6 compared to System 5, resulted in increased break even prices, fewer total pounds produced and what is assumed to be a lower quality end product.

In comparing System 2 (75 day finishing phase) and System 3 (125 day finishing phase), both resulting in a finishing weight of 1017 pounds, feed cost per pound of gain was lower for System 3, and the System 3 steer required 14 fewer days to produce the 521 pounds gain (496 lbs. to 1017 lbs.) desired for both Systems 2 and 3. The reduced production period and greater average daily gains resulted in lower yardage and interest cost per pound of gain for System 3 as compared to System 2.

System 4 resulted in the least cost per pound of gain, and the third highest rate of gain. Yet, System 4 possessed the next to highest break even price. If total production over time were to be considered, System 4, with its high rate of gain and short production period (153 days), may warrant additional consideration. However, when evaluating a single production period, the 452 pounds produced and $.7372 break even price make System 4 inferior to other feeding systems. Also, System 4 would be expected to provide the lowest quality end product.

The performance of feeding Systems 5 and 6 (700 pound placement weight) is heavily dependent upon the light to heavy feeder price differential. This price differential ($.98 and $.84) results in a

break even price of $.7203 for System 5, the second lowest of feeding systems evaluated. However, the 460 pounds produced by System 5 limited profit potential assuming a single production period. As System 5 and 6 both require short production periods, both may warrant further consideration with product over time analysis.

Feeding System 6, incorporating a shortened finishing phase (75 days) and 700 lb. purchase weight, resulting in the highest break even price ($.7520) and the lowest total pounds of product gain (314 pounds) of any system evaluated.

Final "to date" and last "period" production and cost analysis tables are presented in Appendix D.

Summary and Conclusion

Any shortening of the finishing phase reduced profit potential by decreasing total gain, and increasing the break even price (Systems 2 and 6). System 3 (125 day finishing phase) compared to System 2 (75 day finishing phase) emphasizes the results of shortening the finishing phase when a target finishing weight or required gain has been specified. System 3 resulted in a lower break even price, lower total cost of gain, and required 14 fewer days to achieve the selected target weight.[4]

Assuming a finished steer spot market price of $.70, which would

---

[4] Since rations were developed using Stage I and resulted in the optimum rate of gain, i.e. the gain which maximized returns, any ration change will increase production costs, and further reduce profit potential.

be consistent with the light and heavy feeder purchase prices used, the off-feed marginal cost (final "period" total cost per pound gain) of System 1 was the closest to the estimated cash market price. This system, by definition of maximum profitability for a single time period, possess the greatest profit potential (lowest break even price $.7036, and highest total pounds produced at 662 pounds).

Thus, the traditional steer, given current cash market finished and feeder prices, historic feedstuff price ratios, current feedstuff price levels, and assuming a single production period, is not a likely candidate for use as a "hamburger" steer. Any attempt to adjust the production process as associated with the System 1 traditional steer by changing the feeding system (as by shortening the finishing phase) and/or ration, or attempting to influence the quality grade by adjusting Feeding System 1 or the ration used, will result in reduced profit potential for the traditional steer. (The data limit, 1157 pounds was assumed to be an upper weight limit.) The traditional steer carcass, as provided by Feeding System 1, will supply some ground beef. Any additional ground beef resulting from this carcass will only be forthcoming when the price relation between hamburger and the price of other carcass cuts warrants the substitution (relative price of hamburger > relative price of potential substitute cut).

CHAPTER V

SUMMARY AND CONCLUSIONS, LIMITATIONS AND SELECTED ADDITIONAL APPLICATIONS OF THE MODEL

Summary and Conclusions

Interest has been expressed in the evaluation of cattle-type feeding-system combinations as a means of improving production efficiency while maintaining the acceptability of the beef product. To accomplish this evaluation, a field experiment, providing performance data, and a simulation model, using performance data from field trials to expand the number of observations, were utilized. Both cattle type and feeding system were found to greatly influence the production and cost efficiency associated with producing an acceptable (primarily meat sensory characteristics) beef product.

The field trial (traditional and later-maturing cattle types each managed by accelerated and deferred feeding systems) identified the major production and cost factors influencing production and cost efficiency as associated with different cattle-type feeding-system combinations. The results of the field experiment emphasized:

1) Yardage and interest costs per pound gain are largely influenced by the rate of gain. Generally both decrease as daily rate of gain increases.
2) Consumption differences (nutrient content of the ration assumed to be similar) between cattle types and feeding systems when

cattle are of similar weights can greatly influence production efficiency, as the consumption level affects the percent of ration nutrients remaining for production once maintenance requirements have been met. Thus, an effort should be made to maximize consumption.

3) Assuming that the backgrounding ration is not the ration required to produce the optimum rate of gain, i.e. the ration which maximizes production value minus variable costs, and that the desired off-feed target weight and product acceptability can be met with limited or no backgrounging, the backgrounding period should be eliminated and the transition period minimized.
4) If different cattle types achieve similar stages of maturity at different weights they may require a different nutrient mix at similar weights. If a cost analysis is desired, the nutrient mix, as deemed necessary for each cattle-type feeding-system combination evaluated, should be provided by a least cost combination of feedstuffs from a selected feedstuff set.
5) Comparative production efficiency between cattle types of different maturity (stages of maturity as associated with body weight) is greatly influenced by placement weight and the end point efficiency at which comparative measures are made. Placing cattle on feed at comparatively lighter weights improves production efficiency. Comparing different cattle types at the same weight will not reflect the same level of efficiency.

The field experiment showed that the later-maturing steers as compared with traditional steers had an advantage in producing more effi-

ciently, an acceptable beef product. This advantage resulted primarily from the effect of the later maturity on the animals ability to amass more pounds of product. Such ability was great enough to offset the increased maintenance requirements associated with the additional weight. The field experiment also showed that feeding systems, regardless of cattle type, should be designed to best utilize the genetic growth potential of the animal, subject to production costs and feeding restrictions associated with extended intensive production. Consequently the cattle-type feeding-system combination in the field trial resulting in the greatest returns per head was the later-maturing animal on an accelerated feeding system.

Because a field experiment is both time consuming and inflexible for a given time period, a two stage simulation model was developed to provide further production and cost efficiency analysis of cattle-type feeding-system combinations.

The field experiment indicated that production and cost efficiency of various cattle types is dependent upon many constantly or frequently changing cost factors as well as the feeding system employed. Stage I of the simulation model accomodates these cost changes and provides a basis for the comparison of cattle types and the construction of feeding systems. Growth responses are cattle-type specific and are divided into several weight ranges with each range reflecting changes in the physiological state of the animal. Restrictions can be incorporated to provide different ration types within weight ranges. Stage I results in a ration set consisting of rations that provide the nutrients required to produce the optimum daily gain for weight ranges representing the

growth of the animal, and that maximizes product value minus variable cost. From the ration set many feeding systems can be constructed and production phases coordinated.

Stage II provides a production and cost analysis of the constructed feeding system. A "to date" and "period" analysis is available at selected weights, or after a requested number of days. An as-fed feed summary, break even price, and hedging prospects are also provided.

In summary, the two stage model can be used to compare cattle-type specific rations, in combination with selected or constructed feeding systems. Thus the intensive feeding of beef cattle is simulated making possible production and cost comparisons and evaluations by providing a fair basis for analysis.

The model was also used to compare feeding systems designed to provide a "hamburger" steer, utilizing traditional steers. The proposed shortened finishing phase resulted in increased break even costs and reduced the profit potential when a single production period was analyzed. Thus the traditional steer is not a likely choice for use as a "hamburger" steer when single production period feeding programs are practiced.

Limitations

The feeding trial was limited by the time required to obtain results, and the number of cattle types and feeding systems which could be evaluated. The simulation model also has limitations.

1) The data set supplying the nutrient-growth relationships was limited by the upper and lower weight bounds within which data

was provided.

2) The model is dependent upon the repeatability of production characteristics of given cattle types, as reflected by response data. Response data do not reflect changes in genetic potential within cattle types; impact of implanting, crossbreeding, environmental factors; the individual feedstuff's influence on feed intake and feed digestibility or interactions among feedstuffs.
3) The strict digestible protein/metabolizable energy ration assumption, i.e., gain limited to the gain associated with the most limiting nutrient for which response data is included, does not permit evaluation of the gain response associated with imbalances occuring because of restrictions or because of feedstuff prices that are not representative of feeding value.
4) Other than producer estimates, there is no means of selecting price quotes representing marketable products used in determining production value for upper weight range limits. Also, a measure of the change in quality grade is not provided. However, quality grade must be reflected in selected price quotes.
5) Data limitations do not permit establishing specific acceptable limits on the duration of the finishing phase as affected by nutritional plane, total days on feed, beginning and ending weight, degree of finish at placement, and cattle type.
6) The hedging calculation assumes that total pounds produced is equal to the total pounds represented by the futures contract. A perfect hedge is also assumed, i.e. the basis is the same at delivery as when the hedge was initiated.

7) The model does not account for death loss or feed loss between the mill and the digestive system of the animal.

Despite limitations the model still provides a sound and fair comparison of cattle-type feeding-system combinations.

Selected Additional Applications of the Model

Additional applications of the model are noted as follows:

1) The simulation model can be used in coordinating backgrounding and finishing phases of production. Alternative placement and finishing weights can be analyzed utilizing selected production phases.
2) Stage I of the simulation model can be utilized in formulating rations which include available on-farm feed products and by-products. Including farm products is useful in limiting out-of-pocket expenses. Restricitons can be implemented to coordinate on farm production and feed consumption to insure total utilization. The effects of restrictions or need for ingredient supplementation can be identified.
3) Stage II of the simulation model can, with additional field experimentation, be adapted as a ration analyzer. The adaption would enable the model to evaluate rations other than those provided by the Stage I linear programming ration formulation model. The additional information required is the gain response to energy and protein imbalances.
4) The effects of restrictions, on given feedstuffs, consumption, concentrates, and/or roughages can be studied. The effects can

be measured in performance and cost factors. Estimates of protein and energy imbalances will also be provided.

5) The simulation model can provide an estimate of price differentials, e.g. steer versus heifer, which can be paid when purchasing replacement feeders. If the necessary data were available, more cattle types could be compared, and price differentials determined.

6) Stage I of the model provides cattle type specific, optimum rate of gain rations, thus providing a basis on which production and cost comparisons can be made. The use of these rations can improve the evaluation of treatment responses in field trials by eliminating differences associated with cattle-type specific nutrient requirements.

7) Stage I can be adapted to adjust rations for environmental changes that have direct and indirect effects on protein and energy requirements and thus the protein/energy ratio. Temperature affects maintenance requirements; in turn maintenance requirements affect gain if consumption and energy density of the ration are fixed. If gain is affected because of a change in the energy remaining for production after maintenance requirements are met, then protein requirements are affected and a new ratio is required to retain the optimum balance. If regression equations relating metabolizable energy and gain were adapted to include the effect of environmental factors on maintenance energy requirements, then the protein requirement would automatically be adjusted as the optimum rate of gain ration is sought.

8) The model can be used as a budget generator for backgrounding programs, finishing programs and intensive feeding systems.

9) Utilizing the simulation model, profits over time can be analyzed by comparing the placement of lighter weight animals requiring long backgrounding programs versus the placement of a greater number of heavier animals creating more marketings and possibly more pounds marketed.

10) If a high degree of price protection is desired, production utilizing the short hedge of finished animals coupled with a long hedge of feeders can be analyzed. The purchase weights and prices can be associated with the marketing period, marketing weight and related futures quotes. The most desirable weight range for production can be estimated by utilizing this practice.

11) The model could be adapted to formulate rations providing the optimum rate of milk production if nutrient response data (energy, protein, calcium, phosphorus and others) or requirements relating nutrient inputs and milk production were available.

12) The model can be utilized in developing pasture supplements. If the goal of supplementation is to provide additional protein, the protein/energy ratio must be considered to insure utilization. If the supplement is to be limited to five pounds, a determination must be made as to how much protein can be added and become available based on the energy provided by the pasture and supplement. Pasture backgrounding with or without supplementation can be included in the use of the simulation model and

coordinated with other feeding phases as part of a coordinated feeding system.

In summary, additional applications of the model are only limited by the data available and the imagination of the researcher.

SELECTED LIST OF REFERENCES

Armsby, H. P. The Nutrition of Farm Animals. New York: The Macmillan Company., 1917.

Asplund, J. M., and Harris L. E., "Associative Effects on the Digestibility of Energy and the Utilization of Nitrogen in Sheep Fed Simplified Rations." Journal of Animal Science, 32:152, 1971.

Bigwood, E. J., ed. Protein and Amino Acid Functions. Oxford: A. Wheaton & Co., 1972.

Blaxter, K. L., and Mitchell, H. M. "The Factorization of the Protein Requirements of Ruminants and of the Protein Value of Feeds, with Particular Reference to Significance of the Metabolic Fecal Nitrogen." Journal of Animal Science, 7:351, 1948.

Blaxter, K. L., and Wainman, F. W. "The Utilization of the Energy of Different Rations by Sheep and Cattle for Maintenance and for Fattening." Journal of Agricultural Science, 63:113, 1964.

Blaxter, K. L.; Clapperton, J. L.; and Wainman, F. W. "Utilization of Energy and Protein of the Same Diet by Cattle of Different Ages." Journal of Agricultural Science, 67:67, 1966.

Brody, S. Bioenergetics and Growth. New York: Reinhold Publishing Corporation., 1945.

Bullock, J. B., and Logan, S. H. "Cattle Feedlot Marketing Decisions Under Uncertainty." Giannini Foundation, No. 28. April, 1972.

Carroll, F. D.; Nelson, D. D.; Wolf, H.; and Plange, G. "Energy Utilization in Heifers as Affected by a Low-Protein Isocaloric Diet." Journal of Animal Science, 23:758, 1964.

Chestnut, D. M. B., Marsh, R.; Wilson, J. G.; Stewart, T. A.; McCullough, T. A.; and McCallion, T. "Effects of Breed of Cattle on Energy Requirements for Growth." Animal Production, 21:109, 1975.

Church, D. C., and Pond W. G. Basic Animal Nutrition and Feeding. Portland: Schultz, Wack, & Weir., 1974.

Church, D. C. Digestive Physiology and Nutrition of Rumminants. Vol. 1. 2d ed. Portland: Metropolitan Printing Co., 1976.

Church, D. C. Livestock Feeds and Feeding. Portland: Oxford Press., 1978.

Crampton, E. W. "Nutrient-to-Calorie Ratios in Applied Nutrition." Journal of Nutrition, 82:353, 1964.

Dean, G. W.; Carter, H. O.; Wagstaff, H. R.; Olayide, S. O.; Ronning, M.; and Bath, D. L. "Production Functions and Linear Programming Models for Dairy Cattle Feeding." Giannini Foundation, No. 31. December, 1972.

Dent, J. B., and Casey, H. Linear Programming and Animal Nutrition. London: Crosby Lockwood & Son Ltd., 1967.

Dikeman, M. E., and Crouse, J. D. "Chemical Composition of Carcasses from Hereford, Limousin, and Simmental Crossbred Cattle as Related to Growth and Meat Palatability." Journal of Animal Science, 40:463, 1975.

Dukes, H. H. The Physiology of Domestic Animals. 7th ed. Ithaca: Comstock Publishing Associates., 1975.

Fox, D. G.; Johnson, R. R.; Preston, R. L.; Dockerty, T. R.; and Klosterman, E. W. "Protein and Energy Utilization During Compensatory Growth in Beef Cattle." Journal of Animal Science, 34(2):310, 1972.

Garrett, W. N.; Meyer, J. H.; and Lofgreen, G. P. "The Comparative Energy Requirements of Sheep and Cattle for Maintenance and Gain." Journal of Animal Science, 18:528, 1959.

Guenther, J. J.; Bushman, D. H.; Pope, L. S.; and Morrison, R. D. "Growth and Development of the Major Carcass Tissue in Beef Calves from Weaning to Slaughter Weight, with Reference to the Effect of Plane of Nutrition." Journal of Animal Science, 24:1184, 1965.

Hamilton, T. S. "The Heat Increments of Diets Balanced and Unbalanced with Respect to Protein." Journal of Nutrition, 17:583, 1939.

Hedrick, H. B.; Lasley, J. F.; Jain, J. P.; Krause, G. G.; Sibbit, B.; Langford, L.; Comfort, J. E.; and Dyer, A. J. "Quantitative Carcass Characteristics of Reciprocally Crossed Angus, Charolais and Hereford Heifers." Journal of Animal Science, 31:633, 1970.

Jesse, G. W.; Thompson, G. B.; Clark, J. L.; Hedrick, H. B.; and Weimer K. G. "Effects of Ration Energy and Slaughter Weight on Composition of Empty Body and Carcass Gain of Beef Cattle." Journal of Animal Science, 43:418, 1976.

Kay, M.; Bowers, H. B.; and McKiddie, G. "The Protein Requirements of Rapidly Growing Steers." Animal Production, Vol. 10. pt. 1., 1967.

Kay, M., and Mackearmid, A. "A note on the Effect of Changing the Concentration of Protein in the Diet Offered to Fattening Beef Cattle." Animal Production, 16:205, 1973.

Kimple, K. G.; Price, R. V.; Dayton, A. D.; and McCoy, J. H. The Live Cattle Basis at Selected Locations in Kansas, Bulletin 621. Manhattan: Kansas Agricultural Experiment Station, August 1978.

Koch, R. M.; Dikeman, M. E.; Allen, D. M.; May, M.; Crouse, J. D.; and Campion, D. R. "Characterization of Biological Types of Cattle." (III. Carcass Composition, Quality and Palatability) Journal of Animal Science, 43:48, 1976.

Koch, A. R.; Kromann, R. P.; and Wilson, T. R. "Partitioning ME for Maintenance and Gain." Journal of Animal Science, 43:326, 1976.

Kromann, R. P. "A Mathematical Determination of Energy Values of Ration Ingredients." Journal of Animal Science, 26:1131, 1967.

_____. "Evaluation of Net Energy Systems." Journal of Animal Science 37:200, 1973.

Lodge, G. A., and Lamming, G. E., ed. Growth and Development of Mammals. London: Butterworths, 1967.

Lofgreen, G. P., and Garrett, W. N. "A System for Expressing Net Energy Requirements and Feed Values for Growing and Finishing Beef Cattle." Journal of Animal Science, 27:793, 1968.

McDonald, I., and Kay, M. "A Note on the Composition of Live-Weight Gain Estimated by Regression Analysis." Animal Production, 9:553, 1967.

Montgomery, M. J., and Boumgardt, B. R. "Regulation of Food Intake in Rumminants." (1. Pelleted Rations Varying in Energy Concentration) Journal of Dairy Science, 43:569, 1965.

National Academy of Science - National Research Council, Nutrient Requirements of Domestic Animals; No. 4, Nutrient Requirements of Beef Cattle, rev. ed., Washington, D.C., 1976.

_____.Nutrient Requirements of Domestic Animals; No. 3, Nutrient Requirements of Dairy Cattle, rev. ed., Washington, D.C., 1978.

Pike, R. L., and Brown, M. L. Nutrition an Integrated Approach. 2d ed. New York: John Wiley & Sons, Inc., 1975.

Preston, R. L.; Schnakenberg, D. D.; and Pfander, W. H. "Protein Utilization in Rumminants." ("I. Blood Urea Nitrogen as Affected by Protein Intake") Journal of Nutrition, 86:281, 1965.

Preston, R. L., "Protein Requirements of Growing-Finishing Cattle and Lambs." Journal of Nutrition, 90:157, 1966.

Preston, R. L., and Willis, M. B. Intensive Beef Production. 2d ed. London: Billing and Sons Ltd., 1974.

Prior, R. L.; Kohlmeier, R. H.; Cundiff, L. V.; Dikeman, M. E.; and Crouse, J. D. "Influence of Dietary Energy and Protein on Growth and Carcass Compostion in Different Biological Types of Cattle." Journal of Animal Science, 45:132, 1977.

Reid, J. T., and Robb, J. "Relationship of Body Composition to Energy Intake and Energetic Efficiency." Journal of Dairy Science, 54:553, 1971.

Swanson, E. W. "Factors for Computing Requirements of Protein for Maintenance of Cattle." Journal of Dairy Science, 56:1583, 1977.

U.S. Department of Agriculture. Livestock and Meat Statistics, Statistical Bulletin No. 522. Washington, D.C., 1977.

U.S. Meat Animal Research Center. Evaluating Germ Plasm for Beef Production. Cycle 1, Progress Report No. 3. Agricultural Research Service. U.S. Department of Agriculture. April, 1976.

Winchester, C. F.; Hiner, R. L.; and Scarborough V. C. "Some Effects on Beef Cattle of Protein and Energy Restriction." Journal of Animal Science, 16:426, 1957.

APPENDIX A: Example Matrix; Stage I, Traditional Steer, First Transition Ration, 607 lb. to 717 lb. Weight Range

FIGURE 3. Simulation Model - Example Matrix

Item		Constraints				Concentrates				.17 Conc. .83 Roug.	Roughages	
						X_1	X_2	X_3	X_4	X_5	X_6	X_7
		Constraint description	Constraint abbreviation	Constraint level	Sign	Corn CORN.LB	Grain Sorghum GS.LB	Wheat WHEAT.LB	Soybean Meal SBM.LB	Corn Silage CSIL.LB	Alfalfa ALF.LB	Prairie Hay PH.LB
Nutrient Restrictions	Rows 0	Z	Z			-.05066	-.05285	-.06582	-.12635	-.04223	-.03563	-.03153
	1	Maximum dry matter consumption (lbs. DM)	CONS.LB	15.0	≥	1	1	1	1	1	1	1
	2	Metabolizable energy (megcal)	MCAL.ME	0	≥	-1.4923	-1.3109	-1.3290	-1.4424	-1.1476	-.9027	-.8346
	3	Digestable protein (lbs.)	DP.LB	0	≥	-.075	-.071	-.114	-.438	-.047	-.121	-.041
	4	Maximum metabolizable energy (megcal)	MAX.ME	18.6	≥	1.4923	1.3109	1.3290	1.4424	1.1476	.9027	.8346
Response Restrictions Regression Coefficients[a]	5	b_0 (ME)	A	0	≤							
	6	b_1 (ME)	B	-2.28837	≥							
	7	b_0 (DP)	C	0	≤							
	8	b_1 (DP)	D	-1.85109	≥							
	9		F	0	≤							
	10		H	0	≤							
Gain Restriction	11	Gain limit (lbs.)	GAIN.LIM	3.4	≥							
Feedstuff, Yardage, and Interest Cost Restrictions	12	Feedstuff costs ($)	FDS.COST	0	≥	.05866	.05285	.06582	.12635	.04223	.03563	.03153
	13	Acquisition cost ($)	AQ.COST	502.4	≤							
	14		I	0	≥							
	15	Days	DAYS	0	≤							
Feedstuff use Restrictions	16	Total concentrate consumption (lbs. DM)	TOT.CONC	0	=	1	1	1	1	.17		
	17	Nutrient limit as % of total concentrate (lbs.)	J	0	≥			1				
	18	Total consumption (lbs. DM)	TOT.CONS	0	=	1	1	1	1	1	1	1
	19	Nutrient limit as % of total consumption (lbs.)	K	0	≤					.83	1	1

[a] Equation: $G = b_0 + b_1 x_1$ Where: G = daily gain lbs.
x_1 = lbs. DP from meals ME
b_0, b_1 = coefficients

FIGURE 3. Continued

	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}
	AA	BB	CC	DD	FF	HH	GAIN.LB	II	JJ	INTEREST	YARDAGE	KK	MM
Rows 0							.90			.095	.06		
1													
2	1												
3				1									
4													
5	.27231	-1											
6		-1	1										
7				4.05855	-1								
8					-1	1							
9			1			-1							
10						1	-1						
11						1							
12								-1					
13								-1	1		-.06		
14									.00274	-1			
15											1		
16												-1	
17												-.3	
18													-1
19													-.5

APPENDIX B: Stage II Variable Name Description and Units, Flowchart Relating Print and Ration Selection Procedure, and an Example Program of Eight Ration Potential

TABLE 38. Simulation Model - Stage II Variable Names (In Order of Use), description and units

Name	Description	Units
BASIS	Estimated futures minus cash price per lb. at sale date	$
TRUCK	Trucking cost per head	$
VET	Processing and veterinary cost per head	$
WTTD	Weight to date	lb.
PPRICE	Purchase price	$
RINT	Annual interest rate per dollar	$
C	Consumption	lb.
DP	Digestible protein per lb. dry matter	lb.
CME	Consumption of metabolizable energy per lb. dry matter	Mcals.
RUL	Upper limit of ration use	days or lb.
PR	Price of the ration per lb.	$
PCR	Corn per lb. ration dry matter basis	lb.
PMR	Milo per lb. ration dry matter basis	lb.
PWR	Wheat per lb. ration dry matter basis	lb.
PSBMR	Soybean meal per lb. ration dry matter basis	lb.
PAR	Alfalfa per lb. ration dry matter basis	lb.
PCSR	Corn silage per lb. ration dry matter basis	lb.
PPHR	Prairie hay per lb. ration dry matter basis	lb.
PWT	Purchase weight	lb.
DAYTD	Day to date	days
YARDTD	Yardage to date	$
FCOSTD	Feed cost to date	$
GAINTD	Gain to date	lb.
FEEDTD	Feed to date, dry matter	lb.
TDINT	Interest to date	$
TCOSTD	Total cost to date	$
DAYEP	Days end of the period	days
WTEP	Weight end of the period	lb.
FEEDEP	Feed end of the period dry matter	lb.

TABLE 38. Continued

Name	Description	Units
GAINEP	Gain end of the period	lb.
YARDEP	Yardage end of the period	lb.
FCOSEP	Feed cost end of the period	lb.
CORNEP	Corn end of the period as fed	lb.
EPMILO	Milo end of the period as fed	lb.
WHEATEP	Wheat end of the period as fed	lb.
SBMEP	Soybean meal end of the period as fed	lb.
ALFEP	Alfalfa end of the period as fed	lb.
CSILEP	Corn silage end of the period as fed	lb.
PHEP	Prairie hay end of previoud period as fed	lb.
CORNTD	Corn to date as fed	lb.
TDMILO	Milo to date as fed	lb.
WHETTD	Wheat to date as fed	lb.
SBMTD	Soybean meal to date as fed	lb.
ALFTD	Alfalfa to date as fed	lb.
CSILTD	Corn silage to date as fed	lb.
PHTD	Prairie hay to date as fed	lb.
CORNP	Corn period as fed	lb.
PMILO	Milo period as fed	lb.
WHEATP	Wheat period as fed	lb.
SBMP	Soybean meal period as fed	lb.
ALFP	Alfalfa period as fed	lb.
CSILP	Corn silage period as fed	lb.
PHP	Prairie hay period as fed	lb.
TR	Day on transition ration	days
FR	Days on finishing ration	days
CONS	Consumption dry matter	lb.
DPLB	Pounds digestible protein	lb.
CALMME	Mega calories metabolizable energy	Mcals.
GAINDP	Gain provided by digestible protein	lb.

TABLE 38. Continued

Name	Description	Units
GAINME	Gain provided by metabolizable energy	lb.
PINT	Period interest cost	$
ADGTD	Average daily gain	lb.
CONVTD	Conversion (lb. feed/lb. gain) to date dry matter	lb.
FPDTD	Feed per day to date dry matter	lb.
DAYP	Days period	days
FEEDP	Feed period dry matter	lb.
GAINP	Gain period	lb.
YARDP	Yardage period	$
FCOSTP	Feed cost period	$
TDINT	Interest to date	$
COGFTD	Feed cost of gain to date	$
COGYTD	Yardage cost of gain to date	$
COGITD	Interest cost of gain to date	$
TCOSTD	Total cost to date	$
TINVTD	Total investment to date	$
COGTTD	Total cost of gain to date	$
COGFP	Feed cost of gain period	$
COGYP	Yardage cost of gain period	$
COGIP	Interest cost of gain period	$
TCOSTP	Total cost period	$
TINVP	Total investment period	$
COGTP	Total cost of gain period	$
ADGP	Average daily gain period	$
CONVP	Conversion period dry matter	lb.
PPDP	Feed per day period dry matter	lb.
BKEVEN	Break even price	$
HDG20	Hedge price required for $20 margin	$
HDG40	Hedge price required for $40 margin	$
HDG60	Hedge price required for $60 margin	$

FIGURE 4. Simulation Model - Stage II, Partial Flow Diagram Depicting Print and Ration Selection Procedure

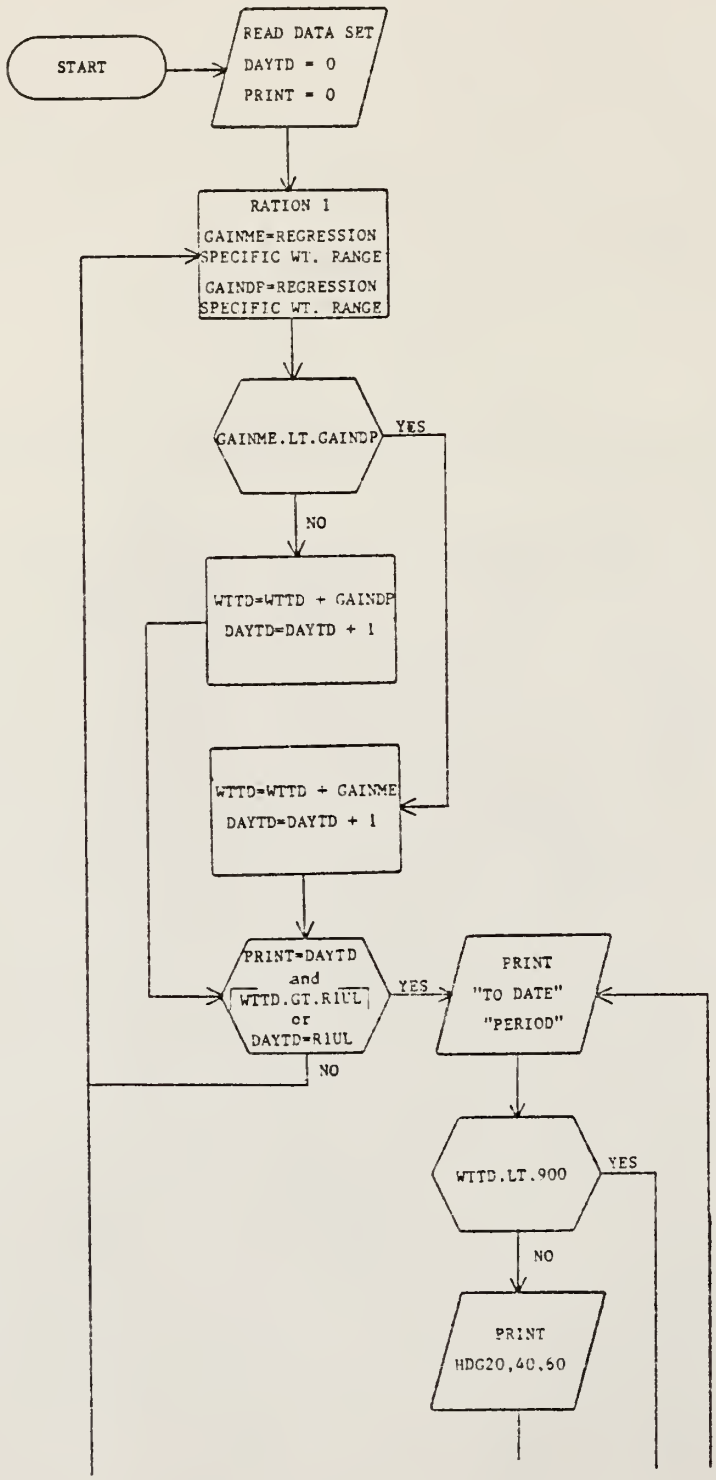

FIGURE 4. Continued

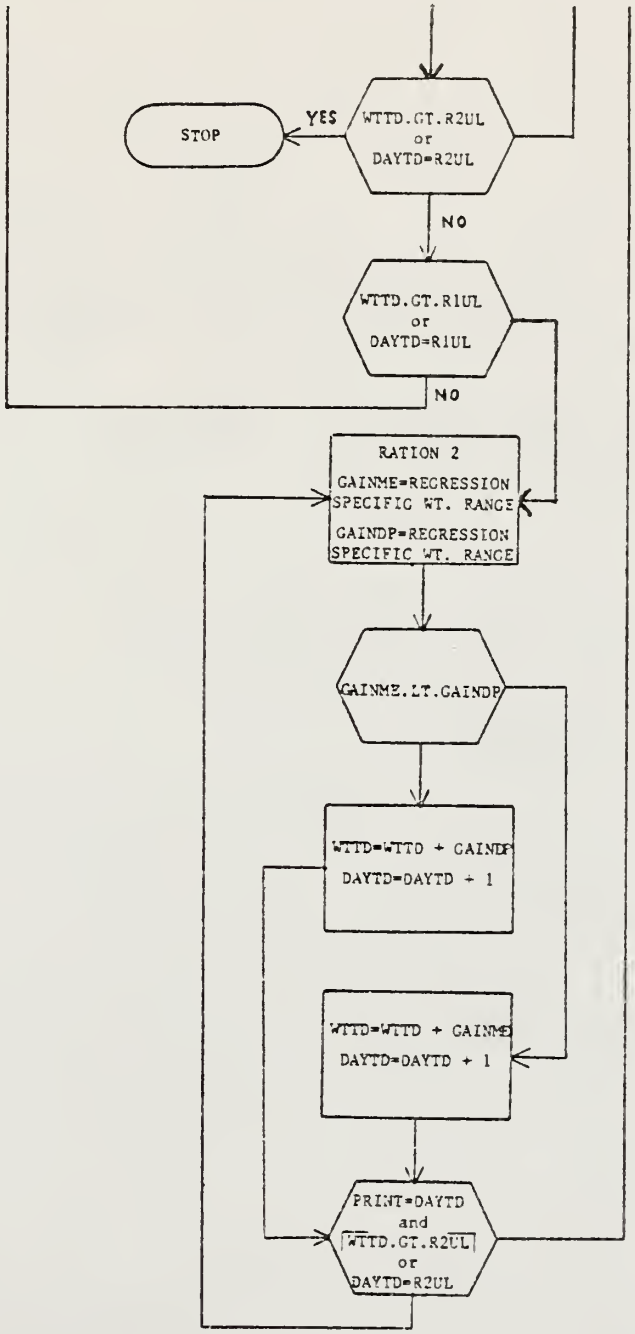

FIGURE 5. Simulation Model - Stage II Complete Computer Program

```
      $JOB            ,P=100
      C*************************************************
      C*                                               *
      C*                                               *
      C*            FEEDING SYSTEM NUMBER ONE          *
      C*                                               *
      C*                FROM CHAPTER III               *
      C*                                               *
      C*                TRADITIONAL STEER              *
      C*                                               *
      C*              496 LBS. TO 1157 LBS.            *
      C*                                               *
      C*             125 DAY FINISHING PHASE           *
      C*                                               *
      C*           EIGHT RATION FEEDING SYSTEM         *
      C*                                               *
      C*                                               *
      C*************************************************
      C
      C
      C
      C
      C************* READ INPUT DATA
      C
    1          READ(5,800)BASIS,TRUCK,VET,WTTD,PPRICE,RINT,
               XC1,C2,C3,C4,C5,C6,C7,C8,
               XDP1,DP2,DP3,DP4,DP5,DP6,DP7,DP8,
               XCME1,CME2,CME3,CME4,CME5,CME6,CME7,CME8,
               XR1UL,R2UL,R3UL,R4UL,R5UL,R6UL,R7UL,R8UL,
               XPR1,PR2,PR3,PR4,PR5,PR6,PR7,PR8,
               XPCR1,PCR2,PCR3,PCR4,PCR5,PCR6,PCR7,PCR8,
               XPMR1,PMR2,PMR3,PMR4,PMR5,PMR6,PMR7,PMR8,
               XPWR1,PWR2,PWR3,PWR4,PWR5,PWR6,PWR7,PWR8,
               XPSBMR1,PSBMR2,PSBMR3,PSBMR4,PSBMR5,PSBMR6,PSBMR7,PSBMR8,
               XPAR1,PAR2,PAR3,PAR4,PAR5,PAR6,PAR7,PAR8,
               XPCSR1,PCSR2,PCSR3,PCSR4,PCSR5,PCSR6,PCSR7,PCSR8,
               XPPHR1,PPHR2,PPHR3,PPHR4,PPHR5,PPHR6,PPHR7,PPHR8
    2       800 FORMAT(6F10.0,12(/8F10.0))
    3          PWT=WTTD*1.02
      C
      C************* COUNTERS
      C
    4          DAYTD=0
    5          YARDTD=0
    6          FCOSTD=0
    7          GAINTD=0
    8          FEEDTD=0
    9          TDINT=0
   10          TCOSTD=0
   11          R1=0
   12          R2=0
   13          R3=0
   14          R4=0
   15          R5=0
   16          R6=0
   17          R7=0
   18          R8=0
   19          DAYEP=0
   20          WTEP=0
   21          FEEDEP=0
```

```
22          GAINEP=0
23          YARDEP=0
24          FCOSEP=0
25          CORNEP=0
26          EPMILO=0
27          WHETEP=0
28          SBMEP=0
29          ALFEP=0
30          CSILEP=0
31          PHEP=0
32          CORNTD=0
33          TDMILO=0
34          WHETTD=0
35          SBMTD=0
36          ALFTD=0
37          CSILTD=0
38          PHTD=0
39          CORNP=0
40          PMILO=0
41          WHEATP=0
42          SBMP=0
43          ALFP=0
44          CSILP=0
45          PHP=0
46          TR=0
47          FR=0
      C
      C
      C************** RATION ONE
      C
48        1 CONS1=C1
49          DPLB=CONS1*DP1
50          CALMME=CONS1*CME1
      C
      C************** REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
      C************** AND DAILY GAIN SPECIFIC FOR RATION 1 WEIGHT RANGE
      C
51          GAINDP=(4.05855*DPLB)-1.85109
      C
      C************** REGRESSION EQUATION RELATING MEGA CALORIES
      C************** METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
      C************** FOR RATION 1 WEIGHT RANGE
      C
52          GAINME=(.27231*CALMME)-2.28837
      C
      C
      C************** SELECT THE MOST LIMITING NUTRIENT (DP OR ME)
      C
53          IF(GAINME.LT.GAINDP)GO TO 100
54          WTTD=WTTD+GAINDP
55          GAINTD=GAINTD+GAINDP
56          GO TO 101
57      100 WTTD=WTTD+GAINME
58          GAINTD=GAINTD+GAINME
59      101 R1=R1+CONS1
60          FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
61          DAYTD=DAYTD+1
      C
      C************** DETERMINE PRINT
      C
```

```
 62          IF(WTTD.GT.R1UL)GO TO 300
 63          GO TO 1
 64      300 PRINT301
         C
         C************* PRINT RATION NAME
         C
 65      301 FORMAT('1','RATION S551B')
         C
         C
         C************* CALCULATE "TO DATE" AND "PERIOD" ANALYSIS
         C
 66      400 YARDTD=DAYTD*.06
 67          FCOSTD=(R1*PR1)+(R2*PR2)+(R3*PR3)+(R4*PR4)+(R5*PR5)+(R6*PR6)+
            X(R7*PR7)+(R8*PR8)
 68          CORNTD=((R1*PCR1)+(R2*PCR2)+(R3*PCR3)+(R4*PCR4)+(R5*PCR5)+
            X(R6*PCR6)+(R7*PCR7)+(R8*PCR8))/.89
 69          TDMILO=((R1*PMR1)+(R2*PMR2)+(R3*PMR3)+(R4*PMR4)+(R5*PMR5)+
            X(R6*PMR6)+(R7*PMR7)+(R8*PMR8))/.89
 70          WHETTD=((R1*PWR1)+(R2*PWR2)+(R3*PWR3)+(R4*PWR4)+(R5*PWR5)+
            X(R6*PWR6)+(R7*PWR7)+(R8*PWR8))/.89
 71          SBMTD=((R1*PSBMR1)+(R2*PSBMR2)+(R3*PSBMR3)+(R4*PSBMR4)+
            X(R5*PSBMR5)+(R6*PSBMR6)+(R7*PSBMR7)+(R8*PSBMR8))/.89
 72          ALFTD=((R1*PAR1)+(R2*PAR2)+(R3*PAR3)+(R4*PAR4)+(R5*PAR5)+
            X(R6*PAR6)+(R7*PAR7)+(R8*PAR8))/.89
 73          CSILTD=((R1*PCSR1)+(R2*PCSR2)+(R3*PCSR3)+(R4*PCSR4)+
            X(R5*PCSR5)+(R6*PCSR6)+(R7*PCSR7)+(R8*PCSR8))/.40
 74          PHTD=((R1*PPHR1)+(R2*PPHR2)+(R3*PPHR3)+(R4*PPHR4)+(R5*PPHR5)+
            X(R6*PPHR6)+(R7*PPHR7)+(R8*PPHR8))/.89
 75          ADGTD=GAINTD/DAYTD
 76          CONVTD=FEEDTD/GAINTD
 77          FPDTD=FEEDTD/DAYTD
 78          DAYP=DAYTD-DAYEP
 79          FEEDP=FEEDTD-FEEDEP
 80          GAINP=GAINTD-GAINEP
 81          YARDP=YARDTD-YARDEP
 82          FCOSTP=FCOSTD-FCOSEP
 83          PINT=((((496.0*PPRICE)*(1.02))+FCOSEP+YARDEP)*(DAYP/365))*RINT
 84          TDINT=TDINT+PINT
 85          COGFTD=FCOSTD/GAINTD
 86          COGYTD=YARDTD/GAINTD
 87          COGITD=TDINT/GAINTD
 88          TCOSTD=FCOSTD+YARDTD+TDINT+VET+TRUCK
 89          TINVTD=TCOSTD+(PWT*PPRICE)
 90          COGTTD=TCOSTD/GAINTD
 91          COGFP=FCOSTP/GAINP
 92          COGYP=YARDP/GAINP
 93          COGIP=PINT/GAINP
 94          TCOSTP=FCOSTP+YARDP+PINT
 95          TINVP=TCOSTP
 96          COGTP=TCOSTP/GAINP
 97          ADGP=GAINP/DAYP
 98          CONVP=FEEDP/GAINP
 99          FPDP=FEEDP/DAYP
100          CORNP=CORNTD-CORNEP
101          PMILO=TDMILO-EPMILO
102          WHEATP=WHETTD-WHETEP
103          SBMP=SBMTD-SBMEP
104          ALFP=ALFTD-ALFEP
105          CSILP=CSILTD-CSILEP
106          PHP=PHTD-PHEP
```

```
      C
      C************* CALCULATE BREAK EVEN
      C
107         BKEVEN=TINVTD/(WTTD*.96)
      C
      C************* CALCULATE HEDGE PRICE REQUIRED
      C
108         HDG20=(BKEVEN+BASIS+.001)+((.0625*DAYTD/365)*.095)+
           X(20/(WTTD*.96))
109         HDG40=(BKEVEN+BASIS+.001)+((.0625*DAYTD/365)*.095)+
           X(40/(WTTD*.96))
110         HDG60=(BKEVEN+BASIS+.001)+((.0625*DAYTD/365)*.095)+
           X(60/(WTTD*.96))
111         DAYEP=DAYTD
112         WTEP=WTTD
113         FEEDEP=FEEDTD
114         GAINEP=GAINTD
115         YARDEP=YARDTD
116         FCOSEP=FCOSTD
117         CORNEP=CORNTD
118         EPMILO=TDMILO
119         WHETEP=WHETTD
120         SBMEP=SBMTD
121         ALFEP=ALFTD
122         CSILEP=CSILTD
123         PHEP=PHTD
      C
      C************* PRINT "TO DATE" AND "PERIOD" ANALYSIS
      C
124         PRINT200
125       200 FORMAT('-','TO DATE',56X,'PERIOD')
126         PRINT202,DAYTD,DAYP
127       202 FORMAT('0','DAYS TO DATE----------------------',3X,F10.4,10X
           X,'ADDITIONAL DAYS----------------------',3X,F10.4)
128         PRINT204,WTTD,WTTD
129       204 FORMAT(' ','WEIGHT TO DATE LBS.----------------',3X,F10.4,10X
           X,'ENDING WEIGHT PERIOD LBS.-----------',3X,F10.4)
130         PRINT206,GAINTD,GAINP
131       206 FORMAT(' ','GAIN TO DATE LBS.------------------',3X,F10.4,10X
           X,'GAIN PERIOD LBS.---------------------',3X,F10.4)
132         PRINT208,ADGTD,ADGP
133       208 FORMAT(' ','AVERAGE DAILY GAIN TO DATE LBS.--------',3X,F10.4,10X
           X,'AVERAGE DAILY GAIN PERIOD LBS.---------',3X,F10.4)
134         PRINT210,FEEDTD,FEEDP
135       210 FORMAT(' ','FEED CONSUMED TO DATE LBS. D.M.---------',3X,F10.4,10X
           X,'FEED CONSUMED PERIOD LBS. D.M.---------',3X,F10.4)
136         PRINT212,FPDTD,FPDP
137       212 FORMAT(' ','FEED CONSUMED PER DAY TO DATE LBS. D.M.-',3X,F10.4,10X
           X,'FEED CONSUMED PER DAY PERIOD LBS. D.M.--',3X,F10.4)
138         PRINT214,CONVTD,CONVP
139       214 FORMAT(' ','FEED PER LB. GAIN TO DATE LBS. D.M.-----',3X,F10.4,10X
           X,'FEED PER LB. GAIN PERIOD LBS. D.M.------',3X,F10.4)
140         PRINT216,FCOSTD,FCOSTP
141       216 FORMAT(' ','FEED COST TO DATE $------------------',3X,F10.4,10X
           X,'FEED COST PERIOD $--------------------',3X,F10.4)
142         PRINT218,YARDTD,YARDP
143       218 FORMAT(' ','YARDAGE TO DATE $--------------------',3X,F10.4,10X
           X,'YARDAGE PERIOD $----------------------',3X,F10.4)
144         PRINT220,TDINT,PINT
145       220 FORMAT(' ','INTEREST TO DATE $-------------------',3X,F10.4,10X
```

```
          X,'INTEREST PERIOD $----------',3X,F10.4)
146         PRINT222,TCOSTD,TCOSTP
147     222 FORMAT(' ','TOTAL PRODUCTION COST TO DATE $---------',3X,F10.4,10X
          X,'TOTAL PRODUCTION COSTS PERIOD $---------',3X,F10.4)
148         PRINT223,TINVTD,TINVP
149     223 FORMAT(' ','TOTAL INVESTMENT TO DATE $-------------',3X,F10.4,10X
          X,'TOTAL INVESTMENT PERIOD $-------------',3X,F10.4)
150         PRINT224,COGFTD,COGFP
151     224 FORMAT(' ','COST OF FEED PER LB. GAIN TO DATE $-----',3X,F10.4,10X
          X,'COST OF FEED PER LB. GAIN PERIOD $------',3X,F10.4)
152         PRINT226,COGYTD,COGYP
153     226 FORMAT(' ','COST OF YARDAGE PER LB. GAIN TO DATE $--',3X,F10.4,10X
          X,'COST OF YARDAGE PER LB. GAIN PERIOD $---',3X,F10.4)
154         PRINT228,COGITD,COGIP
155     228 FORMAT(' ','COST OF INTEREST PER LB. GAIN TO DATE $-',3X,F10.4,10X
          X,'COST OF INTEREST PER LB. GAIN PERIOD $--',3X,F10.4)
156         PRINT230,COGTTD,COGTP
157     230 FORMAT(' ','TOTAL COST PER LB. GAIN TO DATE $-------',3X,F10.4,10X
          X,'TOTAL COST PER LB. GAIN PERIOD $--------',3X,F10.4)
158         PRINT232
159     232 FORMAT('-','FEED SUMMARY TO DATE LBS. AS FED',31X,
          X'FEED SUMMARY PERIOD LBS. AS FED')
160         PRINT234,CORNTD,CORNP
161     234 FORMAT('0',23X,'CORN------------',3X,F10.4,33X,
          X'CORN------------',3X,F10.4)
162         PRINT236,TDMILO,PMILO
163     236 FORMAT(' ',23X,'MILO------------',3X,F10.4,33X,
          X'MILO------------',3X,F10.4)
164         PRINT238,WHETTD,WHEATP
165     238 FORMAT(' ',23X,'WHEAT-----------',3X,F10.4,33X,
          X'WHEAT-----------',3X,F10.4)
166         PRINT240,SBMTD,SBMP
167     240 FORMAT(' ',23X,'SOYBEAN MEAL 44%-',3X,F10.4,33X,
          X'SOYBEAN MEAL 44%-',3X,F10.4)
168         PRINT242,ALFTD;ALFP
169     242 FORMAT(' ',23X,'ALFALFA----------',3X,F10.4,33X,
          X'ALFALFA----------',3X,F10.4)
170         PRINT244,CSILTD,CSILP
171     244 FORMAT(' ',23X,'CORN SILAGE------',3X,F10.4,33X,
          X'CORN SILAGE------',3X,F10.4)
172         PRINT246,PHTD,PHP
173     246 FORMAT(' ',23X,'PRAIRIE HAY------',3X,F10.4,33X,
          X'PRAIRIE HAY------',3X,F10.4)
      C
      C************* PRINT BREAK EVEN
      C
174         PRINT248,BKEVEN
175     248 FORMAT('-',28X,'BREAK EVEN PRICE $/LB.------------------------'
          X,2X,F10.4)
      C
      C************* PRINT HEDGE PRICE REQUIRED
      C
176         IF(WTTD.LT.900.0)GO TO 299
177         PRINT250,HDG20
178     250 FORMAT('0',28X,'HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.-----'
          X,2X,F10.4)
179         PRINT252,HDG40
180     252 FORMAT('0',28X,'HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.-----'
          X,2X,F10.4)
181         PRINT254,HDG60
```

```
182     254 FORMAT('0',28X,'HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.------'
           X,2X,F10.4)
183     295 CONTINUE
      C
      C************* DETERMINE RATION CHANGES
      C
184         IF(WTTD.GT.R8UL)GO TO 500
185         IF(WTTD.GT.R7UL)GO TO 8
186         IF(WTTD.GT.R6UL)GO TO 7
187         IF(WTTD.GT.R5UL)GO TO 6
188         IF(TR.EQ.R4UL)GO TO 5
189         IF(TR.EQ.R3UL)GO TO 4
190         IF(WTTD.GT.R2UL)GO TO 3
191         IF(WTTD.GT.R1UL)GO TO 2
192         GO TO 1
      C
      C
      C************* RATION TWO
      C
193       2 CONS2=C2
194         DPLB=CONS2*DP2
195         CALMME=CONS2*CME2
      C
      C************* REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
      C************* AND DAILY GAIN SPECIFIC FOR RATION 2 WEIGHT RANGE
      C
196         GAINDP=(4.04416*DPLB)-2.10026
      C
      C************* REGRESSION EQUATION RELATING MEGA CALORIES
      C************* METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
      C************* FOR RATION 2 WEIGHT RANGE
      C
197         GAINME=(.22998*CALMME)-2.22363
      C
198         IF(GAINME.LT.GAINDP)GO TO 102
199         WTTD=WTTD+GAINDP
200         GAINTD=GAINTD+GAINDP
201         GO TO 103
202     102 WTTD=WTTD+GAINME
203         GAINTD=GAINTD+GAINME
204     103 R2=R2+CONS2
205         FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
206         DAYTD=DAYTD+1
207         IF(WTTD.GT.R2UL)GO TO 302
208         GO TO 2
209     302 PRINT303
210     303 FORMAT('1','RATION S661B')
211         GO TO 400
      C
      C
      C************* RATION THREE
      C
212       3 CONS3=C3
213         DPLB=CONS3*DP3
214         CALMME=CONS3*CME3
      C
      C************* REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
      C************* AND DAILY GAIN SPECIFIC FOR RATION 3 WEIGHT RANGE
      C
215         GAINDP=(4.4293*DPLB)-2.59526
```

```
      C
      C************* REGRESSION EQUATION RELATING MEGA CALORIES
      C************* METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
      C************* FOR RATION 3 WEIGHT RANGE
      C
216           GAINME=(.20941*CALMME)-2.25412
      C
217           IF(GAINME.LT.GAINDP)GO TO 104
218           WTTD=WTTD+GAINDP
219           GAINTD=GAINTD+GAINDP
220           GO TO 105
221     104   WTTD=WTTD+GAINME
222           GAINTD=GAINTD+GAINME
223     105   R3=R3+CONS3
224           FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
225           DAYTD=DAYTD+1
226           TR=TR+1
227           IF(TR.EQ.R3UL)GO TO 304
228           GO TO 3
229     304   PRINT305
230     305   FORMAT('1','RATION S772T1')
231           GO TO 400
      C
      C
      C************* RATION FOUR
      C
232         4 CONS4=C4
233           DPLB=CONS4*DP4
234           CALMME=CONS4*CME4
      C
      C************* REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
      C************* AND DAILY GAIN SPECIFIC FOR RATION 4 WEIGHT RANGE
      C
235           GAINDP=(4.4293*DPLB)-2.59526
      C
      C************* REGRESSION EQUATION RELATING MEGA CALORIES
      C************* METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
      C************* FOR RATION 4 WEIGHT RANGE
      C
236           GAINME=(.20941*CALMME)-2.25412
      C
237           IF(GAINME.LT.GAINDP)GO TO 106
238           WTTD=WTTD+GAINDP
239           GAINTD=GAINTD+GAINDP
240           GO TO 107
241     106   WTTD=WTTD+GAINME
242           GAINTD=GAINTD+GAINME
243     107   R4=R4+CONS4
244           FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
245           DAYTD=DAYTD+1
246           TR=TR+1
247           IF(TR.EQ.R4UL)GO TO 306
248           GO TO 4
249     306   PRINT307
250     307   FORMAT('1','RATION S772T2')
251           GO TO 400
      C
      C
      C************* RATION FIVE
      C
```

```
252         5 CONS5=C5
253           DPLB=CONS5*DP5
254           CALMME=CONS5*CME5
      C
      C************* REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
      C************* AND DAILY GAIN SPECIFIC FOR RATION 5 WEIGHT RANGE
      C
255           GAINDP=(4.4293*DPLB)-2.59526
      C
      C************* REGRESSION EQUATION RELATING MEGA CALORIES
      C************* METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
      C************* FOR RATION 5 WEIGHT RANGE
      C
256           GAINME=(.20941*CALMME)-2.25412
      C
257           IF(GAINME.LT.GAINDP)GO TO 108
258           WTTD=WTTD+GAINDP
259           GAINTD=GAINTD+GAINDP
260           GO TO 109
261       108 WTTD=WTTD+GAINME
262           GAINTD=GAINTD+GAINME
263       109 R5=R5+CONS5
264           FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
265           DAYTD=DAYTD+1
266           IF(WTTD.GT.R5UL)GO TO 308
267           GO TO 5
268       308 PRINT309
269       309 FORMAT('1','RATION S772F')
270           GO TO 400
      C
      C
      C************* RATION SIX
      C
271         6 CONS6=C6
272           DPLB=CONS6*DP6
273           CALMME=CONS6*CME6
      C
      C************* REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
      C************* AND DAILY GAIN SPECIFIC FOR RATION 6 WEIGHT RANGE
      C
274           GAINDP=(4.62322*DPLB)-2.97643
      C
      C************* REGRESSION EQUATION RELATING MEGA CALORIES
      C************* METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
      C************* FOR RATION 6 WEIGHT RANGE
      C
275           GAINME=(.19087*CALMME)-2.27532
      C
276           IF(GAINME.LT.GAINDP)GO TO 110
277           WTTD=WTTD+GAINDP
278           GAINTD=GAINTD+GAINDP
279           GO TO 111
280       110 WTTD=WTTD+GAINME
281           GAINTD=GAINTD+GAINME
282       111 R6=R6+CONS6
283           FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
284           DAYTD=DAYTD+1
285           IF(WTTD.GT.R6UL)GO TO 310
286           GO TO 6
287       310 PRINT311
```

```
288     311 FORMAT('1','RATION S882F')
289         GO TO 400
        C
        C
        C************* RATION SEVEN
        C
290         7 CONS7=C7
291           DPLB=CONS7*DP7
292           CALMME=CONS7*CME7
        C
        C************* REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
        C************* AND DAILY GAIN SPECIFIC FOR RATION 7 WEIGHT RANGE
        C
293           GAINDP=(4.52459*DPLB)-3.12619
        C
        C************* REGRESSION EQUATION RELATING MEGA CALORIES
        C************* METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
        C************* FOR RATION 7 WEIGHT RANGE
        C
294           GAINME=(.17222*CALMME)-2.23216
        C
295           IF(GAINME.LT.GAINDP)GO TO 112
296           WTTD=WTTD+GAINDP
297           GAINTD=GAINTD+GAINDP
298           GO TO 113
299     112 WTTD=WTTD+GAINME
300           GAINTD=GAINTD+GAINME
301     113 R7=R7+CONS7
302           FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
303           DAYTD=DAYTD+1
304           IF(WTTD.GT.R7UL)GO TO 312
305           GO TO 7
306     312 PRINT313
307     313 FORMAT('1','RATION S992F')
308           GO TO 400
        C
        C
        C************* RATION EIGHT
        C
309         8 CONS8=C8
310           DPLB=CONS8*DP8
311           CALMME=CONS8*CME8
        C
        C************* REGRESSION EQUATION RELATING POUNDS DIGESTABLE PROTEIN
        C************* AND DAILY GAIN SPECIFIC FOR RATION 8 WEIGHT RANGE
        C
312           GAINDP=(4.82609*DPLB)-3.65485
        C
        C************* REGRESSION EQUATION RELATING MEGA CALORIES
        C************* METABOLIZABLE ENERGY AND DAILY GAIN SPECIFIC
        C************* FOR RATION 8 WEIGHT RANGE
        C
313           GAINME=(.16283*CALMME)-2.29197
        C
314           IF(GAINME.LT.GAINDP)GO TO 114
315           WTTD=WTTD+GAINDP
316           GAINTD=GAINTD+GAINDP
317           GO TO 115
318     114 WTTD=WTTD+GAINME
319           GAINTD=GAINTD+GAINME
```

```
320      115 R8=R8+CONS8
321          FEEDTD=R1+R2+R3+R4+R5+R6+R7+R8
322          DAYTD=DAYTD+1
323          IF(WTTD.GT.R8UL)GO TO 314
324          GO TO 8
325      314 PRINT315
326      315 FORMAT('1','RATION S1102F')
327          GO TO 400
328      500 CONTINUE
329      501 PRINT502
330      502 FORMAT('1','NORMAL TERMINATION')
331          STOP
332          END

       $ENTRY
```

APPENDIX C: Stage II "To Date" and "Period" Production and Cost Analysis of the Stage I Constructed Steer and Heifer Feeding Systems

TABLE 39. Stage II "To Date" and "Period" Production and Cost Analysis of the Stage I Constructed Steer Feeding System

RATION S 5518

TO DATE		PERIOD	
DAYS TO DATE	49.0000	ADDITIONAL DAYS	49.0000
WEIGHT TO DATE LBS.	606.2500	ENDING WEIGHT PERIOD LBS.	606.2500
GAIN TO DATE LBS.	110.2538	GAIN PERIOD LBS.	110.2538
AVERAGE DAILY GAIN TO DATE LBS.	2.2501	AVERAGE DAILY GAIN PERIOD LBS.	2.2501
FEED CONSUMED TO DATE LBS. D.M.	735.0000	FEED CONSUMED PERIOD LBS. D.M.	735.0000
FEED CONSUMED PER DAY TO DATE LBS. D.M.	15.0000	FEED CONSUMED PER DAY PERIOD LBS. D.M.	15.0000
FEED PER LB. GAIN TO DATE LBS. D.M.	6.6664	FEED PER LB. GAIN PERIOD LBS. D.M.	6.6664
FEED COST TO DATE $	30.6495	FEED COST PERIOD $	30.6495
YARDAGE TO DATE $	2.9400	YARDAGE PERIOD $	2.9400
INTEREST TO DATE $	6.3232	INTEREST PERIOD $	6.3232
TOTAL PRODUCTION COST TO DATE $	46.4126	TOTAL PRODUCTION COSTS PERIOD $	39.9126
TOTAL INVESTMENT TO DATE $	542.2144	TOTAL INVESTMENT PERIOD $	39.9126
COST OF FEED PER LB. GAIN TO DATE $	0.2780	COST OF FEED PER LB. GAIN PERIOD $	0.2780
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0267	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0267
COST OF INTEREST PER LB. GAIN TO DATE $	0.0574	COST OF INTEREST PER LB. GAIN PERIOD $	0.0574
TOTAL COST PER LB. GAIN TO DATE $	0.4210	TOTAL COST PER LB. GAIN PERIOD $	0.3620

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	58.3045	CORN	58.3045
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	0.0000	SOYBEAN MEAL 44%	0.0000
ALFALFA	205.2219	ALFALFA	205.2219
CORN SILAGE	1251.1530	CORN SILAGE	1251.1530
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.9316

TABLE 39. Continued

RATION S6618

TO DATE		PERIOD	
DAYS TO DATE	90.0000	ADDITIONAL DAYS	41.0000
WEIGHT TO DATE LBS.	698.3999	ENDING WEIGHT PERIOD LBS.	698.3999
GAIN TO DATE LBS.	202.4124	GAIN PERIOD LBS.	92.1587
AVERAGE DAILY GAIN TO DATE LBS.	2.2490	AVERAGE DAILY GAIN PERIOD LBS.	2.2478
FEED CONSUMED TO DATE LBS. D.M.	1477.0960	FEED CONSUMED PERIOD LBS. D.M.	742.0962
FEED CONSUMED PER DAY TO DATE LBS. D.M.	16.4122	FEED CONSUMED PER DAY PERIOD LBS. D.M.	18.0999
FEED PER LB. GAIN TO DATE LBS. D.M.	7.2975	FEED PER LB. GAIN PERIOD LBS. D.M.	8.0524
FEED COST TO DATE $	61.0754	FEED COST PERIOD $	30.4259
YARDAGE TO DATE $	5.4000	YARDAGE PERIOD $	2.4600
INTEREST TO DATE $	11.9724	INTEREST PERIOD $	5.6493
TOTAL PRODUCTION COST TO DATE $	84.9478	TOTAL PRODUCTION COSTS PERIOD $	38.5352
TOTAL INVESTMENT TO DATE $	580.7495	TOTAL INVESTMENT PERIOD $	38.5352
COST OF FEED PER LB. GAIN TO DATE $	0.3017	COST OF FEED PER LB. GAIN PERIOD $	0.3301
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0267	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0267
COST OF INTEREST PER LB. GAIN TO DATE $	0.0591	COST OF INTEREST PER LB. GAIN PERIOD $	0.0613
TOTAL COST PER LB. GAIN TO DATE $	0.4197	TOTAL COST PER LB. GAIN PERIOD $	0.4181

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	58.3045	CORN	0.0000
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	0.0000	SOYBEAN MEAL 44%	0.0080
ALFALFA	351.7231	ALFALFA	146.5013
CORN SILAGE	2603.4380	CORN SILAGE	1352.2840
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.8662

TABLE 39. Continued

RATION S772T1

TO DATE		PERIOD	
DAYS TO DATE	104.0000	ADDITIONAL DAYS	14.0000
WEIGHT TO DATE LBS.	741.0015	ENDING WEIGHT PERIOD LBS.	741.0015
GAIN TO DATE LBS.	245.0151	GAIN PERIOD LBS.	42.6026
AVERAGE DAILY GAIN TO DATE LBS.	2.3559	AVERAGE DAILY GAIN PERIOD LBS.	3.0430
FEED CONSUMED TO DATE LBS. D.M.	1762.6950	FEED CONSUMED PERIOD LBS. D.M.	285.5996
FEED CONSUMED PER DAY TO DATE LBS. D.M.	16.9490	FEED CONSUMED PER DAY PERIOD LBS. D.M.	20.4000
FEED PER LB. GAIN TO DATE LBS. D.M.	7.1942	FEED PER LB. GAIN PERIOD LBS. D.M.	6.7038
FEED COST TO DATE $	74.7842	FEED COST PERIOD $	13.7088
YARDAGE TO DATE $	6.2400	YARDAGE PERIOD $	0.8400
INTEREST TO DATE $	14.0213	INTEREST PERIOD $	2.0488
TOTAL PRODUCTION COST TO DATE $	101.5454	TOTAL PRODUCTION COSTS PERIOD $	16.5976
TOTAL INVESTMENT TO DATE $	597.3472	TOTAL INVESTMENT PERIOD $	16.5976
COST OF FEED PER LB. GAIN TO DATE $	0.3052	COST OF FEED PER LB. GAIN PERIOD $	0.3218
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0255	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0197
COST OF INTEREST PER LB. GAIN TO DATE $	0.0572	COST OF INTEREST PER LB. GAIN PERIOD $	0.0481
TOTAL COST PER LB. GAIN TO DATE $	0.4144	TOTAL COST PER LB. GAIN PERIOD $	0.3896

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	142.0269	CORN	83.7224
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	5.9687
ALFALFA	356.6970	ALFALFA	4.9739
CORN SILAGE	3109.7340	CORN SILAGE	506.2964
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.8397

TABLE 39. Continued

RATION S772T2

TO DATE		PERIOD	
DAYS TO DATE	118.0000	ADDITIONAL DAYS	14.0000
WEIGHT TO DATE LBS.	783.6030	ENDING WEIGHT PERIOD LBS.	783.6030
GAIN TO DATE LBS.	287.6167	GAIN PERIOD LBS.	42.6016
AVERAGE DAILY GAIN TO DATE LBS.	2.4374	AVERAGE DAILY GAIN PERIOD LBS.	3.0430
FEED CONSUMED TO DATE LBS. D.M.	2048.2950	FEED CONSUMED PERIOD LBS. D.M.	285.5996
FEED CONSUMED PER DAY TO DATE LBS. D.M.	17.3584	FEED CONSUMED PER DAY PERIOD LBS. D.M.	20.4000
FEED PER LB. GAIN TO DATE LBS. D.M.	7.1216	FEED PER LB. GAIN PERIOD LBS. D.M.	6.7040
FEED COST TO DATE $	88.2359	FEED COST PERIOD $	13.4517
YARDAGE TO DATE $	7.0800	YARDAGE PERIOD $	0.8400
INTEREST TO DATE $	16.1231	INTEREST PERIOD $	2.1019
TOTAL PRODUCTION COST TO DATE $	117.9390	TOTAL PRODUCTION COSTS PERIOD $	16.3936
TOTAL INVESTMENT TO DATE $	613.7407	TOTAL INVESTMENT PERIOD $	16.3936
COST OF FEED PER LB. GAIN TO DATE $	0.3068	COST OF FEED PER LB. GAIN PERIOD $	0.3158
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0246	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0197
COST OF INTEREST PER LB. GAIN TO DATE $	0.0561	COST OF INTEREST PER LB. GAIN PERIOD $	0.0493
TOTAL COST PER LB. GAIN TO DATE $	0.4101	TOTAL COST PER LB. GAIN PERIOD $	0.3848

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	247.3778	CORN	105.3510
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%-	5.9687	SOYBEAN MEAL 44%-	0.0000
ALFALFA	383.6523	ALFALFA	26.9553
CORN SILAGE	3529.3510	CORN SILAGE	419.6167
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.8159

TABLE 39. Continued

RATION S772F

TO DATE		PERIOD	
DAYS TO DATE	133.0000	ADDITIONAL DAYS	15.0000
WEIGHT TO DATE LBS.	829.2476	ENDING WEIGHT PERIOD LBS.	829.2476
GAIN TO DATE LBS.	333.2612	GAIN PERIOD LBS.	45.6445
AVERAGE DAILY GAIN TO DATE LBS.	2.5057	AVERAGE DAILY GAIN PERIOD LBS.	3.0430
FEED CONSUMED TO DATE LBS. D.M.	2354.2940	FEED CONSUMED PERIOD LBS. D.M.	305.9995
FEED CONSUMED PER DAY TO DATE LBS. D.M.	17.7015	FEED CONSUMED PER DAY PERIOD LBS. D.M.	20.4000
FEED PER LB. GAIN TO DATE LBS. D.M.	7.0644	FEED PER LB. GAIN PERIOD LBS. D.M.	6.7040
FEED COST TO DATE $	102.6485	FEED COST PERIOD $	14.4126
YARDAGE TO DATE $	7.9800	YARDAGE PERIOD $	0.9000
INTEREST TO DATE $	18.4309	INTEREST PERIOD $	2.3078
TOTAL PRODUCTION COST TO DATE $	135.5594	TOTAL PRODUCTION COSTS PERIOD $	17.6203
TOTAL INVESTMENT TO DATE $	631.3611	TOTAL INVESTMENT PERIOD $	17.6203
COST OF FEED PER LB. GAIN TO DATE $	0.3080	COST OF FEED PER LB. GAIN PERIOD $	0.3158
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0239	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0197
COST OF INTEREST PER LB. GAIN TO DATE $	0.0553	COST OF INTEREST PER LB. GAIN PERIOD $	0.0506
TOTAL COST PER LB. GAIN TO DATE $	0.4068	TOTAL COST PER LB. GAIN PERIOD $	0.3860

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	360.2534	CORN	112.8756
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	0.0000
ALFALFA	412.5330	ALFALFA	28.8806
CORN SILAGE	3978.9400	CORN SILAGE	449.5891
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.7931

TABLE 39. Continued

RATION S882F

TO DATE		PERIOD	
DAYS TO DATE	169.0000	ADDITIONAL DAYS	36.0000
WEIGHT TO DATE LBS.	939.7349	ENDING WEIGHT PERIOD LBS.	939.7349
GAIN TO DATE LBS.	443.7485	GAIN PERIOD LBS.	110.4873
AVERAGE DAILY GAIN TO DATE LBS.	2.6257	AVERAGE DAILY GAIN PERIOD LBS.	3.0691
FEED CONSUMED TO DATE LBS. D.M.	3167.8910	FEED CONSUMED PERIOD LBS. D.M.	813.5964
FEED CONSUMED PER DAY TO DATE LBS. D.M.	18.7449	FEED CONSUMED PER DAY PERIOD LBS. D.M.	22.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	7.1389	FEED PER LB. GAIN PERIOD LBS. D.M.	7.3637
FEED COST TO DATE $	140.7248	FEED COST PERIOD $	38.0763
YARDAGE TO DATE $	10.1400	YARDAGE PERIOD $	2.1600
INTEREST TO DATE $	24.1131	INTEREST PERIOD $	5.6822
TOTAL PRODUCTION COST TO DATE $	181.4779	TOTAL PRODUCTION COSTS PERIOD $	45.9185
TOTAL INVESTMENT TO DATE $	677.2795	TOTAL INVESTMENT PERIOD $	45.9185
COST OF FEED PER LB. GAIN TO DATE $	0.3171	COST OF FEED PER LB. GAIN PERIOD $	0.3446
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0229	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0195
COST OF INTEREST PER LB. GAIN TO DATE $	0.0543	COST OF INTEREST PER LB. GAIN PERIOD $	0.0514
TOTAL COST PER LB. GAIN TO DATE $	0.4090	TOTAL COST PER LB. GAIN PERIOD $	0.4156

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	626.2720	CORN	266.0186
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	0.0000
ALFALFA	445.9910	ALFALFA	33.4580
CORN SILAGE	5346.5930	CORN SILAGE	1367.6530
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7507
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7967
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.8188
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.8410

TABLE 39. Continued

RATION S992F

TO DATE		PERIOD	
DAYS TO DATE	205.0000	ADDITIONAL DAYS	36.0000
WEIGHT TO DATE LBS.	1048.3760	ENDING WEIGHT PERIOD LBS.	1048.3760
GAIN TO DATE LBS.	552.3901	GAIN PERIOD LBS.	108.6416
AVERAGE DAILY GAIN TO DATE LBS.	2.6946	AVERAGE DAILY GAIN PERIOD LBS.	3.0178
FEED CONSUMED TO DATE LBS. D.M.	4053.4870	FEED CONSUMED PERIOD LBS. D.M.	885.5962
FEED CONSUMED PER DAY TO DATE LBS. D.M.	19.7731	FEED CONSUMED PER DAY PERIOD LBS. D.M.	24.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	7.3381	FEED PER LB. GAIN PERIOD LBS. D.M.	8.1515
FEED COST TO DATE $	182.0821	FEED COST PERIOD $	41.3573
YARDAGE TO DATE $	12.3000	YARDAGE PERIOD $	2.1600
INTEREST TO DATE $	30.1722	INTEREST PERIOD $	6.0592
TOTAL PRODUCTION COST TO DATE $	231.0543	TOTAL PRODUCTION COSTS PERIOD $	49.5765
TOTAL INVESTMENT TO DATE $	726.8560	TOTAL INVESTMENT PERIOD $	49.5765
COST OF FEED PER LB. GAIN TO DATE $	0.3296	COST OF FEED PER LB. GAIN PERIOD $	0.3807
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0223	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0199
COST OF INTEREST PER LB. GAIN TO DATE $	0.0546	COST OF INTEREST PER LB. GAIN PERIOD $	0.0558
TOTAL COST PER LB. GAIN TO DATE $	0.4183	TOTAL COST PER LB. GAIN PERIOD $	0.4563

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	898.0205	CORN	271.7485
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%-	5.9687	SOYBEAN MEAL 44%-	0.0000
ALFALFA	453.7522	ALFALFA	7.7612
CORN SILAGE	6938.6750	CORN SILAGE	1592.0820
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7222
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7664
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7863
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.8062

TABLE 39. Continued

RATION S1102F

TO DATE		PERIOD	
DAYS TO DATE	244.0000	ADDITIONAL DAYS	39.0000
WEIGHT TO DATE LBS.	1158.2160	ENDING WEIGHT PERIOD LBS.	1158.2160
GAIN TO DATE LBS.	662.2300	GAIN PERIOD LBS.	109.8398
AVERAGE DAILY GAIN TO DATE LBS.	2.7141	AVERAGE DAILY GAIN PERIOD LBS.	2.8164
FEED CONSUMED TO DATE LBS. D.M.	5040.1790	FEED CONSUMED PERIOD LBS. D.M.	986.6921
FEED CONSUMED PER DAY TO DATE LBS. D.M.	20.6565	FEED CONSUMED PER DAY PERIOD LBS. D.M.	25.2998
FEED PER LB. GAIN TO DATE LBS. D.M.	7.6109	FEED PER LB. GAIN PERIOD LBS. D.M.	8.9830
FEED COST TO DATE $	228.1608	FEED COST PERIOD $	46.0786
YARDAGE TO DATE $	14.6400	YARDAGE PERIOD $	2.3400
INTEREST TO DATE $	37.1780	INTEREST PERIOD $	7.0058
TOTAL PRODUCTION COST TO DATE $	286.4788	TOTAL PRODUCTION COSTS PERIOD $	55.4244
TOTAL INVESTMENT TO DATE $	782.2805	TOTAL INVESTMENT PERIOD $	55.4244
COST OF FEED PER LB. GAIN TO DATE $	0.3445	COST OF FEED PER LB. GAIN PERIOD $	0.4195
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0221	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0213
COST OF INTEREST PER LB. GAIN TO DATE $	0.0561	COST OF INTEREST PER LB. GAIN PERIOD $	0.0638
TOTAL COST PER LB. GAIN TO DATE $	0.4326	TOTAL COST PER LB. GAIN PERIOD $	0.5046

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	1198.7950	CORN	300.7754
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	0.0000
ALFALFA	453.7522	ALFALFA	0.0000
CORN SILAGE	8736.1830	CORN SILAGE	1797.5070
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7036
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7465
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7645
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.7825

TABLE 40. Stage II "To Date" and "Period" Production and Cost Analysis of the Stage 1 Constructed Heifer Feeding System

RATION H551B

TO DATE		PERIOD	
DAYS TO DATE	57.0000	ADDITIONAL DAYS	57.0000
WEIGHT TO DATE LBS.	607.0081	ENDING WEIGHT PERIOD LBS.	607.0081
GAIN TO DATE LBS.	111.0107	GAIN PERIOD LBS.	111.0107
AVERAGE DAILY GAIN TO DATE LBS.	1.9476	AVERAGE DAILY GAIN PERIOD LBS.	1.9476
FEED CONSUMED TO DATE LBS. D.M.	889.1938	FEED CONSUMED PERIOD LBS. D.M.	889.1938
FEED CONSUMED PER DAY TO DATE LBS. D.M.	15.5999	FEED CONSUMED PER DAY PERIOD LBS. D.M.	15.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	8.0100	FEED PER LB. GAIN PERIOD LBS. D.M.	8.0100
FEED COST TO DATE $	35.8345	FEED COST PERIOD $	35.8345
YARDAGE TO DATE $	3.4200	YARDAGE PERIOD $	3.4200
INTEREST TO DATE $	6.3798	INTEREST PERIOD $	6.3798
TOTAL PRODUCTION COST TO DATE $	52.1343	TOTAL PRODUCTION COSTS PERIOD $	45.6343
TOTAL INVESTMENT TO DATE $	482.1663	TOTAL INVESTMENT PERIOD $	45.6343
COST OF FEED PER LB. GAIN TO DATE $	0.3228	COST OF FEED PER LB. GAIN PERIOD $	0.3228
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0308	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0308
COST OF INTEREST PER LB. GAIN TO DATE $	0.0575	COST OF INTEREST PER LB. GAIN PERIOD $	0.0575
TOTAL COST PER LB. GAIN TO DATE $	0.4696	TOTAL COST PER LB. GAIN PERIOD $	0.4111

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	0.0000	CORN	0.0000
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	0.0000	SOYBEAN MEAL 44%	0.0000
ALFALFA	193.1249	ALFALFA	193.1249
CORN SILAGE	1657.9010	CORN SILAGE	1657.9010
PRAIRIE HAY	60.9447	PRAIRIE HAY	60.9447

BREAK EVEN PRICE $/LB. 0.8274

TABLE 40. Continued

RATION H661B

TO DATE		PERIOD	
DAYS TO DATE	101.0000	ADDITIONAL DAYS	44.0000
WEIGHT TO DATE LBS.	692.6555	ENDING WEIGHT PERIOD LBS.	692.6555
GAIN TO DATE LBS.	196.6595	GAIN PERIOD LBS.	85.6488
AVERAGE DAILY GAIN TO DATE LBS.	1.9471	AVERAGE DAILY GAIN PERIOD LBS.	1.9466
FEED CONSUMED TO DATE LBS. D.M.	1681.1930	FEED CONSUMED PERIOD LBS. D.M.	792.0000
FEED CONSUMED PER DAY TO DATE LBS. D.M.	16.6455	FEED CONSUMED PER DAY PERIOD LBS. D.M.	18.0000
FEED PER LB. GAIN TO DATE LBS. D.M.	8.5488	FEED PER LB. GAIN PERIOD LBS. D.M.	9.2471
FEED COST TO DATE $	67.5145	FEED COST PERIOD $	31.6800
YARDAGE TO DATE $	6.0600	YARDAGE PERIOD $	2.6400
INTEREST TO DATE $	11.7149	INTEREST PERIOD $	5.3351
TOTAL PRODUCTION COST TO DATE $	91.7894	TOTAL PRODUCTION COSTS PERIOD $	39.6551
TOTAL INVESTMENT TO DATE $	521.8213	TOTAL INVESTMENT PERIOD $	39.6551
COST OF FEED PER LB. GAIN TO DATE $	0.3433	COST OF FEED PER LB. GAIN PERIOD $	0.3699
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0308	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0308
COST OF INTEREST PER LB. GAIN TO DATE $	0.0596	COST OF INTEREST PER LB. GAIN PERIOD $	0.0623
TOTAL COST PER LB. GAIN TO DATE $	0.4667	TOTAL COST PER LB. GAIN PERIOD $	0.4630

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	0.0000	CORN	0.0000
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	0.0000	SOYBEAN MEAL 44%	0.0000
ALFALFA	299.8220	ALFALFA	106.6971
CORN SILAGE	3125.4770	CORN SILAGE	1467.5750
PRAIRIE HAY	184.5501	PRAIRIE HAY	123.6054

BREAK EVEN PRICE $/LB. 0.7848

TABLE 40. Continued

RATION H661T1

TO DATE		PERIOD	
DAYS TO DATE	115.0000	ADDITIONAL DAYS	14.0000
WEIGHT TO DATE LBS.	728.8826	ENDING WEIGHT PERIOD LBS.	728.8826
GAIN TO DATE LBS.	232.8893	GAIN PERIOD LBS.	36.2298
AVERAGE DAILY GAIN TO DATE LBS.	2.0251	AVERAGE DAILY GAIN PERIOD LBS.	2.5878
FEED CONSUMED TO DATE LBS. D.M.	1933.1930	FEED CONSUMED PERIOD LBS. D.M.	252.0000
FEED CONSUMED PER DAY TO DATE LBS. D.M.	16.8104	FEED CONSUMED PER DAY PERIOD LBS. D.M.	18.0000
FEED PER LB. GAIN TO DATE LBS. D.M.	8.3009	FEED PER LB. GAIN PERIOD LBS. D.M.	6.9556
FEED COST TO DATE $	79.5853	FEED COST PERIOD $	12.0708
YARDAGE TO DATE $	6.9000	YARDAGE PERIOD $	0.8400
INTEREST TO DATE $	13.5279	INTEREST PERIOD $	1.8130
TOTAL PRODUCTION COST TO DATE $	106.5132	TOTAL PRODUCTION COSTS PERIOD $	14.7238
TOTAL INVESTMENT TO DATE $	536.5449	TOTAL INVESTMENT PERIOD $	14.7238
COST OF FEED PER LB. GAIN TO DATE $	0.3417	COST OF FEED PER LB. GAIN PERIOD $	0.3332
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0296	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0232
COST OF INTEREST PER LB. GAIN TO DATE $	0.0581	COST OF INTEREST PER LB. GAIN PERIOD $	0.0500
TOTAL COST PER LB. GAIN TO DATE $	0.4574	TOTAL COST PER LB. GAIN PERIOD $	0.4064

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	74.4957	CORN	74.4957
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.0683	SOYBEAN MEAL 44%	5.0683
ALFALFA	305.2300	ALFALFA	5.4080
CORN SILAGE	3566.3500	CORN SILAGE	440.8735
PRAIRIE HAY	184.5501	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.7668

TABLE 40. Continued

RATION H772T2

TO DATE		PERIOD	
DAYS TO DATE	129.0000	ADDITIONAL DAYS	14.0000
WEIGHT TO DATE LBS.	764.6106	ENDING WEIGHT PERIOD LBS.	764.6106
GAIN TO DATE LBS.	268.6182	GAIN PERIOD LBS.	35.7289
AVERAGE DAILY GAIN TO DATE LBS.	2.0823	AVERAGE DAILY GAIN PERIOD LBS.	2.5521
FEED CONSUMED TO DATE LBS. D.M.	2215.9930	FEED CONSUMED PERIOD LBS. D.M.	282.7998
FEED CONSUMED PER DAY TO DATE LBS. D.M.	17.1782	FEED CONSUMED PER DAY PERIOD LBS. D.M.	20.2000
FEED PER LB. GAIN TO DATE LBS. D.M.	8.2496	FEED PER LB. GAIN PERIOD LBS. D.M.	7.9152
FEED COST TO DATE $	92.7355	FEED COST PERIOD $	13.1502
YARDAGE TO DATE $	7.7400	YARDAGE PERIOD $	0.8400
INTEREST TO DATE $	15.3849	INTEREST PERIOD $	1.8570
TOTAL PRODUCTION COST TO DATE $	122.3603	TOTAL PRODUCTION COSTS PERIOD $	15.8471
TOTAL INVESTMENT TO DATE $	552.3921	TOTAL INVESTMENT PERIOD $	15.8471
COST OF FEED PER LB. GAIN TO DATE $	0.3452	COST OF FEED PER LB. GAIN PERIOD $	0.3681
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0288	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0235
COST OF INTEREST PER LB. GAIN TO DATE $	0.0573	COST OF INTEREST PER LB. GAIN PERIOD $	0.0520
TOTAL COST PER LB. GAIN TO DATE $	0.4555	TOTAL COST PER LB. GAIN PERIOD $	0.4435

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	157.4927	CORN	82.9970
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.0683	SOYBEAN MEAL 44%	0.0000
ALFALFA	305.2300	ALFALFA	0.0000
CORN SILAGE	4088.6810	CORN SILAGE	522.3308
PRAIRIE HAY	184.5501	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.7526

TABLE 40. Continued

RATION H772F

TO DATE		PERIOD	
DAYS TO DATE	154.0000	ADDITIONAL DAYS	25.0000
WEIGHT TO DATE LBS.	828.4106	ENDING WEIGHT PERIOD LBS.	828.4106
GAIN TO DATE LBS.	332.4182	GAIN PERIOD LBS.	63.8000
AVERAGE DAILY GAIN TO DATE LBS.	2.1586	AVERAGE DAILY GAIN PERIOD LBS.	2.5520
FEED CONSUMED TO DATE LBS. D.M.	2720.9920	FEED CONSUMED PERIOD LBS. D.M.	504.9993
FEED CONSUMED PER DAY TO DATE LBS. D.M.	17.6688	FEED CONSUMED PER DAY PERIOD LBS. D.M.	20.2000
FEED PER LB. GAIN TO DATE LBS. D.M.	8.1855	FEED PER LB. GAIN PERIOD LBS. D.M.	7.9153
FEED COST TO DATE $	116.2179	FEED COST PERIOD $	23.4825
YARDAGE TO DATE $	9.2400	YARDAGE PERIOD $	1.5000
INTEREST TO DATE $	18.7864	INTEREST PERIOD $	3.4016
TOTAL PRODUCTION COST TO DATE $	150.7443	TOTAL PRODUCTION COSTS PERIOD $	28.3840
TOTAL INVESTMENT TO DATE $	580.7761	TOTAL INVESTMENT PERIOD $	28.3840
COST OF FEED PER LB. GAIN TO DATE $	0.3496	COST OF FEED PER LB. GAIN PERIOD $	0.3681
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0278	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0235
COST OF INTEREST PER LB. GAIN TO DATE $	0.0565	COST OF INTEREST PER LB. GAIN PERIOD $	0.0533
TOTAL COST PER LB. GAIN TO DATE $	0.4535	TOTAL COST PER LB. GAIN PERIOD $	0.4449

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	305.7012	CORN	148.2085
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.0683	SOYBEAN MEAL 44%	0.0000
ALFALFA	305.2300	ALFALFA	0.0000
CORN SILAGE	5021.4140	CORN SILAGE	932.7324
PRAIRIE HAY	184.5501	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB. 0.7303

TABLE 40. Continued

RATION H882F

TO DATE		PERIOD	
DAYS TO DATE	201.0000	ADDITIONAL DAYS	47.0000
WEIGHT TO DATE LBS.	937.1096	ENDING WEIGHT PERIOD LBS.	937.1096
GAIN TO DATE LBS.	441.1172	GAIN PERIOD LBS.	108.6990
AVERAGE DAILY GAIN TO DATE LBS.	2.1946	AVERAGE DAILY GAIN PERIOD LBS.	2.3127
FEED CONSUMED TO DATE LBS. D.M.	3703.2890	FEED CONSUMED PERIOD LBS. D.M.	982.2964
FEED CONSUMED PER DAY TO DATE LBS. D.M.	18.4243	FEED CONSUMED PER DAY PERIOD LBS. D.M.	20.8999
FEED PER LB. GAIN TO DATE LBS. D.M.	8.3953	FEED PER LB. GAIN PERIOD LBS. D.M.	9.0368
FEED COST TO DATE $	161.9929	FEED COST PERIOD $	45.7750
YARDAGE TO DATE $	12.0600	YARDAGE PERIOD $	2.8200
INTEREST TO DATE $	25.4686	INTEREST PERIOD $	6.6822
TOTAL PRODUCTION COST TO DATE $	206.0215	TOTAL PRODUCTION COSTS PERIOD $	55.2772
TOTAL INVESTMENT TO DATE $	636.0535	TOTAL INVESTMENT PERIOD $	55.2772
COST OF FEED PER LB. GAIN TO DATE $	0.3672	COST OF FEED PER LB. GAIN PERIOD $	0.4211
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0273	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0259
COST OF INTEREST PER LB. GAIN TO DATE $	0.0577	COST OF INTEREST PER LB. GAIN PERIOD $	0.0615
TOTAL COST PER LB. GAIN TO DATE $	0.4670	TOTAL COST PER LB. GAIN PERIOD $	0.5085

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	603.5906	CORN	297.8894
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.0683	SOYBEAN MEAL 44%	0.0000
ALFALFA	311.5208	ALFALFA	6.2908
CORN SILAGE	6800.3510	CORN SILAGE	1778.9370
PRAIRIE HAY	184.5501	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7070
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7710
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7933
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.8155

TABLE 40. Continued

RATION H992F

TO DATE		PERIOD	
DAYS TO DATE	254.0000	ADDITIONAL DAYS	53.0000
WEIGHT TO DATE LBS.	1048.8670	ENDING WEIGHT PERIOD LBS.	1048.8670
GAIN TO DATE LBS.	552.8752	GAIN PERIOD LBS.	111.7581
AVERAGE DAILY GAIN TO DATE LBS.	2.1767	AVERAGE DAILY GAIN PERIOD LBS.	2.1086
FEED CONSUMED TO DATE LBS. D.M.	4848.0820	FEED CONSUMED PERIOD LBS. D.M.	1144.7920
FEED CONSUMED PER DAY TO DATE LBS. D.M.	19.0869	FEED CONSUMED PER DAY PERIOD LBS. D.M.	21.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	8.7689	FEED PER LB. GAIN PERIOD LBS. D.M.	10.2435
FEED COST TO DATE $	215.4548	FEED COST PERIOD $	53.4619
YARDAGE TO DATE $	15.2400	YARDAGE PERIOD $	3.1800
INTEREST TO DATE $	33.6353	INTEREST PERIOD $	8.1667
TOTAL PRODUCTION COST TO DATE $	270.8298	TOTAL PRODUCTION COSTS PERIOD $	64.8085
TOTAL INVESTMENT TO DATE $	700.8618	TOTAL INVESTMENT PERIOD $	64.8085
COST OF FEED PER LB. GAIN TO DATE $	0.3897	COST OF FEED PER LB. GAIN PERIOD $	0.4784
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0276	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0285
COST OF INTEREST PER LB. GAIN TO DATE $	0.0608	COST OF INTEREST PER LB. GAIN PERIOD $	0.0731
TOTAL COST PER LB. GAIN TO DATE $	0.4899	TOTAL COST PER LB. GAIN PERIOD $	0.5799

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	951.1448	CORN	347.5542
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.0683	SOYBEAN MEAL 44%	0.0000
ALFALFA	311.5208	ALFALFA	0.0000
CORN SILAGE	8889.0270	CORN SILAGE	2088.6750
PRAIRIE HAY	184.5501	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.6961
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7585
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7784
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.7983

APPENDIX D: "To Date" and "Period" Production and Cost Analysis for Feeding Systems 1 through 6. Chapter V - Evaluation of Traditional "Hamburger" Steers

TABLE 41. "To Date" and "Period" Production and Cost Analyses for Simulated Feeding Systems 1 Through 6, "Hamburger" Steer

RATION S1102F

TO DATE		PERIOD	
DAYS TO DATE	244.0000	ADDITIONAL DAYS	39.0000
WEIGHT TO DATE LBS.	1158.2160	ENDING WEIGHT PERIOD LBS.	1158.2160
GAIN TO DATE LBS.	662.2300	GAIN PERIOD LBS.	109.8398
AVERAGE DAILY GAIN TO DATE LBS.	2.7141	AVERAGE DAILY GAIN PERIOD LBS.	2.8164
FEED CONSUMED TO DATE LBS. D.M.	5040.1790	FEED CONSUMED PERIOD LBS. D.M.	986.6921
FEED CONSUMED PER DAY TO DATE LBS. D.M.	20.6565	FEED CONSUMED PER DAY PERIOD LBS. D.M.	25.2998
FEED PER LB. GAIN TO DATE LBS. D.M.	7.6109	FEED PER LB. GAIN PERIOD LBS. D.M.	8.9830
FEED COST TO DATE $	228.1608	FEED COST PERIOD $	46.0786
YARDAGE TO DATE $	14.6400	YARDAGE PERIOD $	2.3400
INTEREST TO DATE $	37.1780	INTEREST PERIOD $	7.0058
TOTAL PRODUCTION COST TO DATE $	286.4788	TOTAL PRODUCTION COSTS PERIOD $	55.4244
TOTAL INVESTMENT TO DATE $	782.2805	TOTAL INVESTMENT PERIOD $	55.4244
COST OF FEED PER LB. GAIN TO DATE $	0.3445	COST OF FEED PER LB. GAIN PERIOD $	0.4195
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0221	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0213
COST OF INTEREST PER LB. GAIN TO DATE $	0.0561	COST OF INTEREST PER LB. GAIN PERIOD $	0.0638
TOTAL COST PER LB. GAIN TO DATE $	0.4326	TOTAL COST PER LB. GAIN PERIOD $	0.5046

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	1198.7950	CORN	300.7754
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	0.0000
ALFALFA	453.7522	ALFALFA	0.0000
CORN SILAGE	8736.1830	CORN SILAGE	1797.5070
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7036
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7465
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7645
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.7825

FEEDING SYSTEM 2.

RATION S992F

TO DATE		PERIOD	
DAYS TO DATE	195.0000	ADDITIONAL DAYS	26.0000
WEIGHT TO DATE LBS.	1016.6070	ENDING WEIGHT PERIOD LBS.	1016.6070
GAIN TO DATE LBS.	520.6216	GAIN PERIOD LBS.	78.4634
AVERAGE DAILY GAIN TO DATE LBS.	2.6699	AVERAGE DAILY GAIN PERIOD LBS.	3.0178
FEED CONSUMED TO DATE LBS. D.M.	3802.8880	FEED CONSUMED PERIOD LBS. D.M.	639.5977
FEED CONSUMED PER DAY TO DATE LBS. D.M.	19.5020	FEED CONSUMED PER DAY PERIOD LBS. D.M.	24.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	7.3045	FEED PER LB. GAIN PERIOD LBS. D.M.	8.1515
FEED COST TO DATE $	170.1565	FEED COST PERIOD $	29.8692
YARDAGE TO DATE $	11.7000	YARDAGE PERIOD $	1.5600
INTEREST TO DATE $	28.4670	INTEREST PERIOD $	4.3731
TOTAL PRODUCTION COST TO DATE $	216.8236	TOTAL PRODUCTION COSTS PERIOD $	35.8023
TOTAL INVESTMENT TO DATE $	712.6252	TOTAL INVESTMENT PERIOD $	35.8023
COST OF FEED PER LB. GAIN TO DATE $	0.3268	COST OF FEED PER LB. GAIN PERIOD $	0.3807
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0225	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0199
COST OF INTEREST PER LB. GAIN TO DATE $	0.0547	COST OF INTEREST PER LB. GAIN PERIOD $	0.0557
TOTAL COST PER LB. GAIN TO DATE $	0.4165	TOTAL COST PER LB. GAIN PERIOD $	0.4563

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	807.4849	CORN	196.2629
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	0.0000
ALFALFA	453.6082	ALFALFA	5.6052
CORN SILAGE	6502.4490	CORN SILAGE	1149.8350
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7302
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7749
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7953
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.8158

FEEDING SYSTEM 3.

RATION S992F

TO DATE		PERIOD	
DAYS TO DATE	181.0000	ADDITIONAL DAYS	26.0000
WEIGHT TO DATE LBS.	1017.3240	ENDING WEIGHT PERIOD LBS.	1017.3240
GAIN TO DATE LBS.	521.3293	GAIN PERIOD LBS.	78.4634
AVERAGE DAILY GAIN TO DATE LBS.	2.8803	AVERAGE DAILY GAIN PERIOD LBS.	3.0178
FEED CONSUMED TO DATE LBS. D.M.	3559.6890	FEED CONSUMED PERIOD LBS. D.M.	639.5977
FEED CONSUMED PER DAY TO DATE LBS. D.M.	19.6668	FEED CONSUMED PER DAY PERIOD LBS. D.M.	24.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	6.8281	FEED PER LB. GAIN PERIOD LBS. D.M.	8.1515
FEED COST TO DATE $	166.0205	FEED COST PERIOD $	29.8692
YARDAGE TO DATE $	10.8600	YARDAGE PERIOD $	1.5600
INTEREST TO DATE $	26.4566	INTEREST PERIOD $	4.3394
TOTAL PRODUCTION COST TO DATE $	209.8371	TOTAL PRODUCTION COSTS PERIOD $	35.7686
TOTAL INVESTMENT TO DATE $	705.6387	TOTAL INVESTMENT PERIOD $	35.7686
COST OF FEED PER LB. GAIN TO DATE $	0.3185	COST OF FEED PER LB. GAIN PERIOD $	0.3807
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0208	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0199
COST OF INTEREST PER LB. GAIN TO DATE $	0.0507	COST OF INTEREST PER LB. GAIN PERIOD $	0.0553
TOTAL COST PER LB. GAIN TO DATE $	0.4025	TOTAL COST PER LB. GAIN PERIOD $	0.4559

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	1139.1340	CORN	196.2629
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	13.7562	SOYBEAN MEAL 44%	0.0000
ALFALFA	352.5032	ALFALFA	5.6052
CORN SILAGE	5549.9020	CORN SILAGE	1149.8350
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7225
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7669
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7874
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.8079

FEEDING SYSTEM 4.

RATION S882F

TO DATE		PERIOD	
DAYS TO DATE	153.0000	ADDITIONAL DAYS	39.0000
WEIGHT TO DATE LBS.	948.3835	ENDING WEIGHT PERIOD LBS.	948.3835
GAIN TO DATE LBS.	452.3867	GAIN PERIOD LBS.	119.6946
AVERAGE DAILY GAIN TO DATE LBS.	2.9568	AVERAGE DAILY GAIN PERIOD LBS.	3.0691
FEED CONSUMED TO DATE LBS. D.M.	2903.5900	FEED CONSUMED PERIOD LBS. D.M.	881.3960
FEED CONSUMED PER DAY TO DATE LBS. D.M.	18.9777	FEED CONSUMED PER DAY PERIOD LBS. D.M.	22.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	6.4184	FEED PER LB. GAIN PERIOD LBS. D.M.	7.3637
FEED COST TO DATE $	137.8675	FEED COST PERIOD $	41.2493
YARDAGE TO DATE $	9.1800	YARDAGE PERIOD $	2.3400
INTEREST TO DATE $	21.8441	INTEREST PERIOD $	6.0829
TOTAL PRODUCTION COST TO DATE $	175.3916	TOTAL PRODUCTION COSTS PERIOD $	49.6722
TOTAL INVESTMENT TO DATE $	671.1934	TOTAL INVESTMENT PERIOD $	49.6722
COST OF FEED PER LB. GAIN TO DATE $	0.3048	COST OF FEED PER LB. GAIN PERIOD $	0.3446
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0203	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0195
COST OF INTEREST PER LB. GAIN TO DATE $	0.0483	COST OF INTEREST PER LB. GAIN PERIOD $	0.0508
TOTAL COST PER LB. GAIN TO DATE $	0.3877	TOTAL COST PER LB. GAIN PERIOD $	0.4150

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	1097.0150	CORN	288.1865
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%-	13.7562	SOYBEAN MEAL 44%-	0.0000
ALFALFA	323.5469	ALFALFA	36.2461
CORN SILAGE	4067.7830	CORN SILAGE	1481.6260
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7372
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7827
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.8046
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.8266

FEEDING SYSTEM 5.

RATION S1102F

TO DATE		PERIOD	
DAYS TO DATE	154.0000	ADDITIONAL DAYS	39.0000
WEIGHT TO DATE LBS.	1159.7910	ENDING WEIGHT PERIOD LBS.	1159.7910
GAIN TO DATE LBS.	459.8022	GAIN PERIOD LBS.	109.8398
AVERAGE DAILY GAIN TO DATE LBS.	2.9857	AVERAGE DAILY GAIN PERIOD LBS.	2.8164
FEED CONSUMED TO DATE LBS. D.M.	3567.2850	FEED CONSUMED PERIOD LBS. D.M.	986.6943
FEED CONSUMED PER DAY TO DATE LBS. D.M.	23.1642	FEED CONSUMED PER DAY PERIOD LBS. D.M.	25.2999
FEED PER LB. GAIN TO DATE LBS. D.M.	7.7583	FEED PER LB. GAIN PERIOD LBS. D.M.	8.9830
FEED COST TO DATE $	167.2733	FEED COST PERIOD $	46.0786
YARDAGE TO DATE $	9.2400	YARDAGE PERIOD $	2.3400
INTEREST TO DATE $	19.6992	INTEREST PERIOD $	5.6140
TOTAL PRODUCTION COST TO DATE $	202.2125	TOTAL PRODUCTION COSTS PERIOD $	54.0326
TOTAL INVESTMENT TO DATE $	801.9724	TOTAL INVESTMENT PERIOD $	54.0326
COST OF FEED PER LB. GAIN TO DATE $	0.3638	COST OF FEED PER LB. GAIN PERIOD $	0.4195
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0201	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0213
COST OF INTEREST PER LB. GAIN TO DATE $	0.0428	COST OF INTEREST PER LB. GAIN PERIOD $	0.0511
TOTAL COST PER LB. GAIN TO DATE $	0.4398	TOTAL COST PER LB. GAIN PERIOD $	0.4919

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	1140.5150	CORN	300.7754
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	0.0000
ALFALFA	99.0362	ALFALFA	0.0000
CORN SILAGE	6147.0000	CORN SILAGE	1797.5110
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7203
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7618
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.7797
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.7977

FEEDING SYSTEM 6.

RATION S992F

TO DATE		PERIOD	
DAYS TO DATE	103.0000	ADDITIONAL DAYS	25.0000
WEIGHT TO DATE LBS.	1013.7370	ENDING WEIGHT PERIOD LBS.	1013.7370
GAIN TO DATE LBS.	313.7485	GAIN PERIOD LBS.	75.4456
AVERAGE DAILY GAIN TO DATE LBS.	3.0461	AVERAGE DAILY GAIN PERIOD LBS.	3.0178
FEED CONSUMED TO DATE LBS. D.M.	2285.3930	FEED CONSUMED PERIOD LBS. D.M.	614.9978
FEED CONSUMED PER DAY TO DATE LBS. D.M.	22.1883	FEED CONSUMED PER DAY PERIOD LBS. D.M.	24.5999
FEED PER LB. GAIN TO DATE LBS. D.M.	7.2842	FEED PER LB. GAIN PERIOD LBS. D.M.	8.1515
FEED COST TO DATE $	107.4090	FEED COST PERIOD $	28.7204
YARDAGE TO DATE $	6.1800	YARDAGE PERIOD $	1.5000
INTEREST TO DATE $	12.4975	INTEREST PERIOD $	3.3077
TOTAL PRODUCTION COST TO DATE $	132.0864	TOTAL PRODUCTION COSTS PERIOD $	33.5281
TOTAL INVESTMENT TO DATE $	731.8462	TOTAL INVESTMENT PERIOD $	33.5281
COST OF FEED PER LB. GAIN TO DATE $	0.3423	COST OF FEED PER LB. GAIN PERIOD $	0.3807
COST OF YARDAGE PER LB. GAIN TO DATE $	0.0197	COST OF YARDAGE PER LB. GAIN PERIOD $	0.0199
COST OF INTEREST PER LB. GAIN TO DATE $	0.0398	COST OF INTEREST PER LB. GAIN PERIOD $	0.0438
TOTAL COST PER LB. GAIN TO DATE $	0.4210	TOTAL COST PER LB. GAIN PERIOD $	0.4444

FEED SUMMARY TO DATE LBS. AS FED		FEED SUMMARY PERIOD LBS. AS FED	
CORN	749.1570	CORN	188.7144
MILO	0.0000	MILO	0.0000
WHEAT	0.0000	WHEAT	0.0000
SOYBEAN MEAL 44%	5.9687	SOYBEAN MEAL 44%	0.0000
ALFALFA	96.4491	ALFALFA	5.3899
CORN SILAGE	3368.9790	CORN SILAGE	1105.6120
PRAIRIE HAY	0.0000	PRAIRIE HAY	0.0000

BREAK EVEN PRICE $/LB.	0.7520
HEDGE PRICE REQUIRED FOR $20.00 MARGIN $/LB.	0.7952
HEDGE PRICE REQUIRED FOR $40.00 MARGIN $/LB.	0.8158
HEDGE PRICE REQUIRED FOR $60.00 MARGIN $/LB.	0.8363

MANAGEMENT OF INTENSIVE FEEDING SYSTEMS FOR BEER CATTLE

by

STANLEY M. MYERS

B.S., Kansas State University, 1975

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTERS OF SCIENCE

Agricultural Economics

Department of Economics

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1979

ABSTRACT

The objective of the study was to evaluate the production efficiency associated with different cattle types and feeding systems. Each cattle-type feeding-system combination was required to produce a product of acceptable quality.

A field trial was established utilizing traditional and later-maturing cattle types each managed by an accelerated and a deferred feeding system. Large differences in production efficiency, assuming like and acceptable end products, were found to be associated with different cattle types, different feeding systems and the different cattle-type feeding-system combinations observed. Small differences in product acceptability were found when the above groupings were evaluated.

Since field trials are generally limited by the time required to obtain results and by the restricted and inflexible set of observations, a two stage simulation model was developed to expand the evaluation of production efficiency associated with cattle-type feeding-system combinations. Linear programming was utilized in Stage I to formulate rations which provide the optimum rate of gain, i.e. maximize production value minus variable cost. Stage I provides the ration set from which feeding systems can be constructed and production phases coordinated.

Stage II of the simulation model utilizes selected input costs, the constructed feeding systems and nutritional data from Stage I to provide a "to date" and "period" analysis of cost and production factors for each cattle-type feeding-system combination. Utilization of the model permits multiple comparisons of the cattle-type feeding-system combinations

not readily available from field trials.

The model was applied to (1) compare production efficiency of traditional steers and heifers, and (2) utilize traditional steers in evaluating feeding systems constructed to produce ground beef.